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The JOURNAL OF ELECTRICITY

AN ILLUSTRATED REVIEW OF THE INDUSTRIAL APPLICATIONS OF ELECTRICITY, GAS AND POWER.

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TABLE OF CONTENTS.

ARTICLES—
The Nevada County Power Transmission..... (Illustrated)..... 107
An Economical Air Plant, now being Installed in the North Star Mine (Illustrated) by EDWARD A. RIX, P. E..... 110
Centrifugal Pumps and Hydraulic Principles, by L. M. HOSKINS..... 113
Resonance in Boiler Explosions, by LIEUT. W. STUART-SMITH, U. S. N..... 115
The Sacramento Electric Power and Light Co. (Illustrated)..... 123

EDITORIAL—
The Far West Recognized..... 117
Competition in the Telegraph..... 117
Electric vs. "Coal Car" Transmission..... 117
Light Haulage by Means of Electric Motors.. 118
An Inaccurate Estimate of Power Transmission..... 118

PASSING COMMENT—
An Editorial Review of Current Events and of Our Contemporaries..... 119

LITERATURE—
Electrical Engineering Leaflets, by HOUSTOUN AND KENNELLY..... 120
The Electrical Transmission of Energy, by ARTHUR VAUGHAN ABBOTT..... 121

THE TRADE—
Tie Plates in Electric Railways (Ill'd)..... 125
Special Reversible Mill Motors (Ill'd)..... 124
Lundell Dynamos for Gas Engines (Ill'd)..... 125
New Westinghouse Offices..... 125
Handling a Heavy Cable (Ill'd)..... 125

THE LAY PRESS..... 126

REPORTS OF THE MONTH..... 127

Buyers' Directory.....*Page* v. *Advertising Index*.....*Page* iii.

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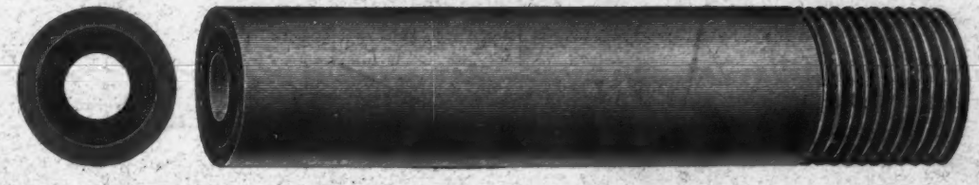

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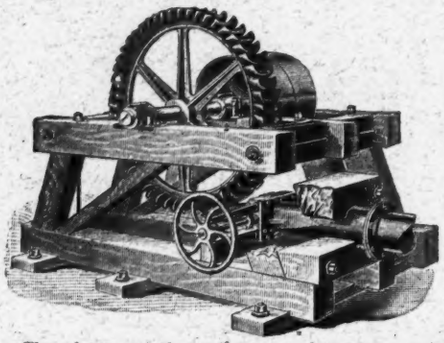

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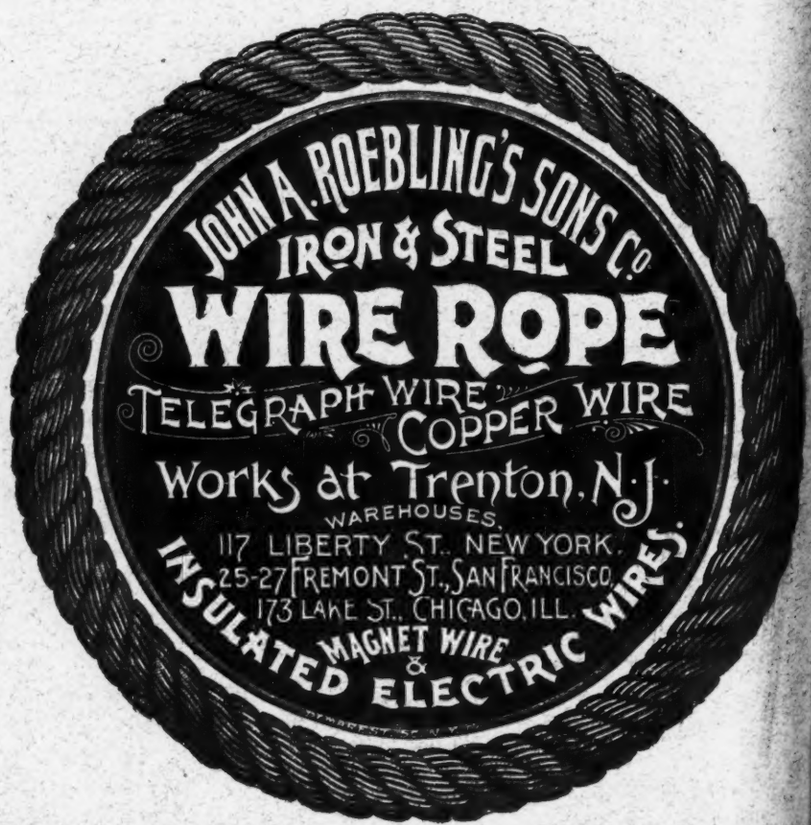

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ADVERTISERS' INDEX.

	PAGE
Alexander, Geo. Webb	ix
Alexander & Bro., Leo E.	ix
Askin & Cook	xi
Babcock & Wilcox	iii
Bolton & Strong	v
Brooks & Co., J. W.	opposite page vi
California Electrical Works	vi
Chemical Paint Co.	ix
Cobb, M. E., Edward S.	iii
Dick Company, William	viii
Electrical Construction and Repair Co.	viii
Electrical Engineering Company	ix
For Sale Advertisements	iii
Gamewell Fire Alarm Telegraph Co.	xi
Girard Water Wheel Co.	v
Gotterke & Low	ix
Helios Electric Company	vi
Interior Conduit & Insulation Company	i
Johns Manufacturing Co., H. W.	iv
Kaufman, C. B. & Co	opposite page 107
Klein's Electrical Works, John M.	vii
Lamont, G. E	vii
Martin, Jno.	xii
New York Insulated Wire Company, The	ix
Okonite Company, Ltd., The	i
Paraffine Paint Company, The	iv
Pelton Water Wheel Company, The	xi
Reger & Atwater	vii
Risdon Iron Works	ii
Roebling's Sons Company, The John A.	ii
San Francisco Typewriting Exchange	ix
Sprout, E. E., Sidney	iii
Stanley Electric Manufacturing Company	xii
Stuart-Smith, E. E., M. E., W.	iii
Sterling Supply Company, The	viii
Van der Naillen School of Electricity	v
Wagner Electric Manufacturing Company	vi
Want Advertisements	v
Washburn & Moen Manufacturing Company, The	xi
Wass, D. D.	vii
Westinghouse Electric & Manufacturing Company, The	x
Weston Electrical Instrument Company, The	i

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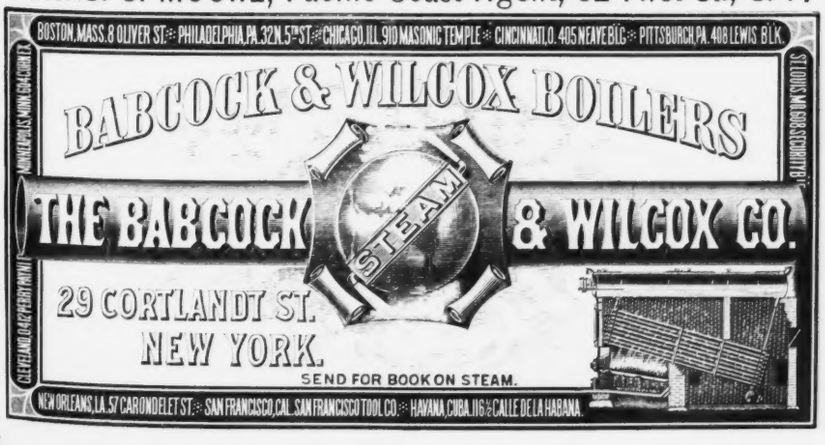
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Helios Electric Co. of Philad'a ... vi
Sterling Supply Co..... viii
Westinghouse Elec. and Mfg. Co.. x

Asbestos Goods.
H. W. Johns Manufacturing Co... iv

Bicycles.
Geo. Webb Alexander..... ix

Books and Publications.
Geo. Webb Alexander..... ix
The Journal of Electricity..... iv

Brushes.
C. B. Kaufman & Co.....opp. 107
D. D. Wass.. vii
J. W. Brooks & Co.. .....opp. vi
Reger & Atwater..... vii

Carbons.
J. W. Brooks & Co .....opp. vi

Car Registers.
C. B. Kaufman & Co.....opp. 107
J. W. Brooks & Co.....opp. vi
Reger & Atwater vii

Constructing Engineers.
Elec. Construction and Repair Co. —
John M. Klein's Elec. Works... . vii
John Martin..... xii
Wm. Dick Co..... viii

Display Work.
Askin & Cook..... xi
Elec. Cons. and Repair Co..... viii

Dynamos and Motors.
California Electrical Works..... vi
D. D. Wass vii
Electrical Engineering Co. ix
Interior Conduit and Ins. Co..... i
Jno. Martin..... xii
John M. Klein's Elec. Works..... vii
J. W. Brooks & Co.....opp. vi
Westinghouse Elec. and Mfg. Co. x

Educational.
Van der Naillen's School of Electricity..... v

Electrical Engineers.
W. Stuart-Smith & Sidney Sprout iii

Electrical Repairing.
California Electrical Works..... vi
D. D. Wass..... vii
John M. Klein's Elec. Works... vii
William Dick Co..... viii

Electrical Supplies.
California Electrical Works..... vi
D. D. Wass vii
Gotterke & Low.... ix
John M. Klein's Electrical Works vii
J. W. Brooks & Co.....opp. vi
Sterling Supply Co..... iv
Westinghouse Elec. and Mfg. Co. x

Engravers.
Bolton & Strong..... v

Fan Motors.
California Electrical Works..... vi
Interior Conduit and Ins. Co..... i
John M. Klein's Electrical Works vii
J. W. Brooks & Co .....opp. vi
Westinghouse Elec. and Mfg. Co... x

Fire Alarm Telegraphs.
The Gamewell Fire Alarm Telegraph Co..... xi

Insulated Wires. (See Wires and Cables)

Glass Blowers.
G. E. Lamont..... vii

Incandescent Lamps.
California Electrical Works..... vi
G. E. Lamont..... vii
John M. Klein's Elec. Works..... vii
J. W. Brooks & Co.....opp. vi
Westinghouse Elec. and Mfg. Co. x

Instruments.
California Electrical Works..... vi
Weston Electrical Instrument Co. i

Insulating Compounds.
C. B. Kaufman & Co.....opp. 107
Chemical Paint Co..... ix
New York Insulated Wire Co..... ix
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Interior Conduit.
Interior Conduit and Ins. Co..... i

Marine Supplies.
D. D. Waas..... vii

Mechanical Engineers.
Edward S. Cobb iii
W. Stuart-Smith & Sidney Sprout iii

Mica Goods.
C. B. Kaufman & Co.....opp. 107
H. W. Johns Manufacturing Co.. iv
J. W. Brooks & Co.....opp. vi
Reger & Atwater vii

Mining Apparatus.
Electrical Engineering Co..... ix
John Martin..... xii
Risdon Iron Works ii
Westinghouse Elec. and Mfg. Co.. x

Power Transmission.
Electrical Engineering Co..... ix
John Martin xii
Risdon Iron Works..... ii
Westinghouse Elec. and Mfg. Co.. x

Railway Supplies.
C. B. Kaufman & Co.....opp. 107
J. W. Brooks & Co .....opp. vi
Reger & Atwater vii

Steam Boilers.
Risdon Iron Works ii
The Babcock & Wilcox Co..... iii

Steam Engines.
Risdon Iron Works..... ii

Telephones.
California Electrical Works..... vi
John M. Klein's Elec. Works..... vii

Transformers.
John Martin xii
Wagner Electric and Mfg. Co..... vi
Westinghouse Elec. & Mfg. Co.... x

Typewriting Supplies.
Leo. E. Alexander & Bro ix
S. F. Typewriting Exchange..... ix

Water Wheels.
Risdon Iron Works..... ii
The Pelton Water Wheel Co..... xi

Wires and Cables.
California Electrical Works..... vi
John A. Roeblings Sons Co..... ii
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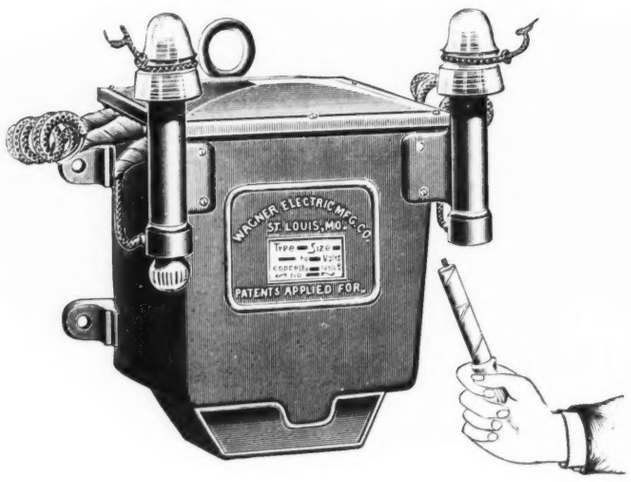

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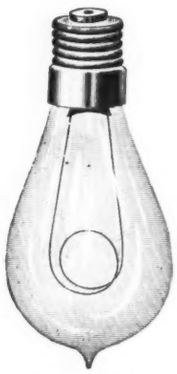

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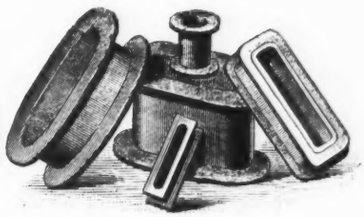

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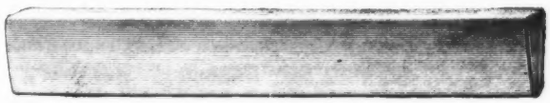

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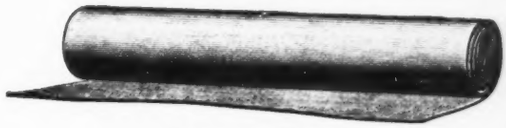

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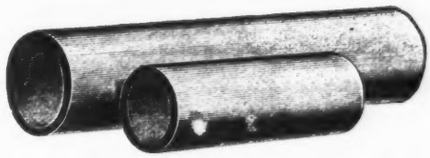

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ADVERTISERS' INDEX.

	PAGE
Alexander, Geo. Webb	ix
Alexander & Bro., Leo E.	ix
Askin & Cook	xi
Babcock & Wilcox	iii
Bolton & Strong	v
Brooks & Co., J. W.	opposite page vi
California Electrical Works	vi
Chemical Paint Co.	ix
Cobb, M. E., Edward S.	iii
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Electrical Construction and Repair Co.	viii
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For Sale Advertisements	iii
Gamewell Fire Alarm Telegraph Co.	xi
Girard Water Wheel Co.	v
Gotterke & Low	ix
Helios Electric Company	vi
Interior Conduit & Insulation Company	i
Johns Manufacturing Co., H. W	iv
Kaufman, C. B. & Co	opposite page 107
Klein's Electrical Works, John M.	vii
Lamont, G. E	vii
Martin, Jno.	xii
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Okonite Company, Ltd., The	i
Paraffine Paint Company, The	iv
Pelton Water Wheel Company, The	xi
Reger & Atwater	vii
Risdon Iron Works	ii
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Van der Naillen School of Electricity	v
Wagner Electric Manufacturing Company	vi
Want Advertisements	v
Washburn & Moen Manufacturing Company, The	xi
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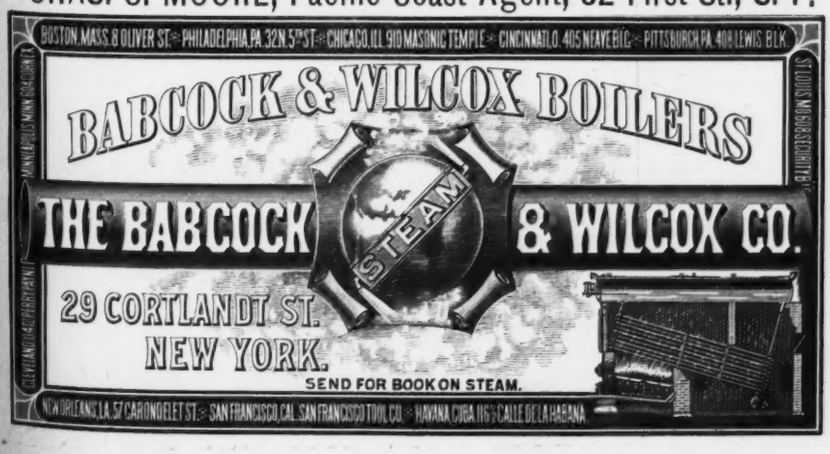
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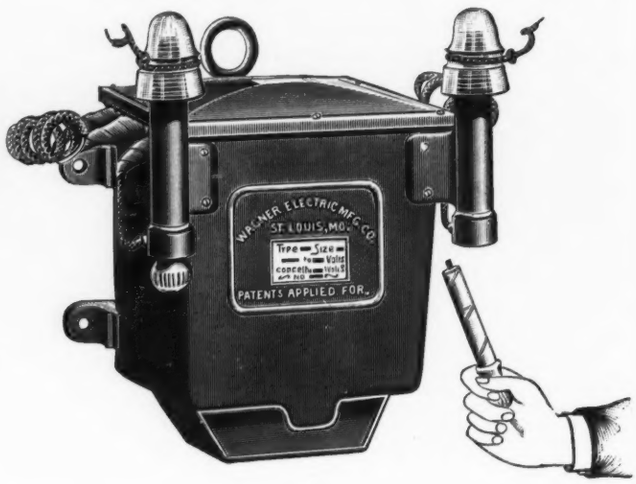

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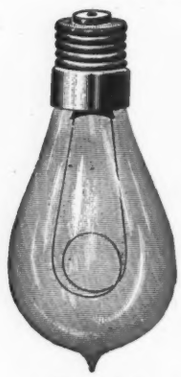

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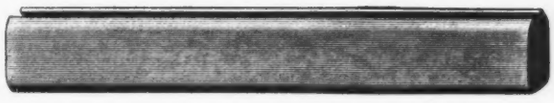

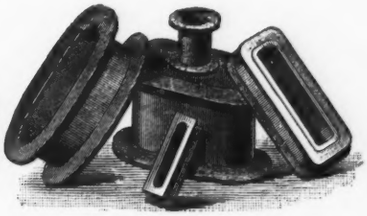

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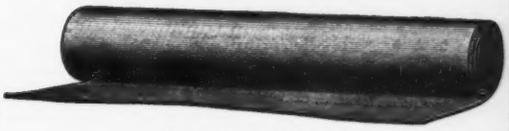

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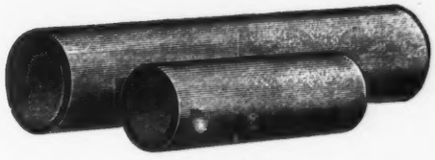

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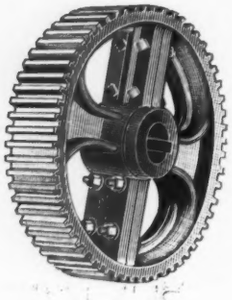

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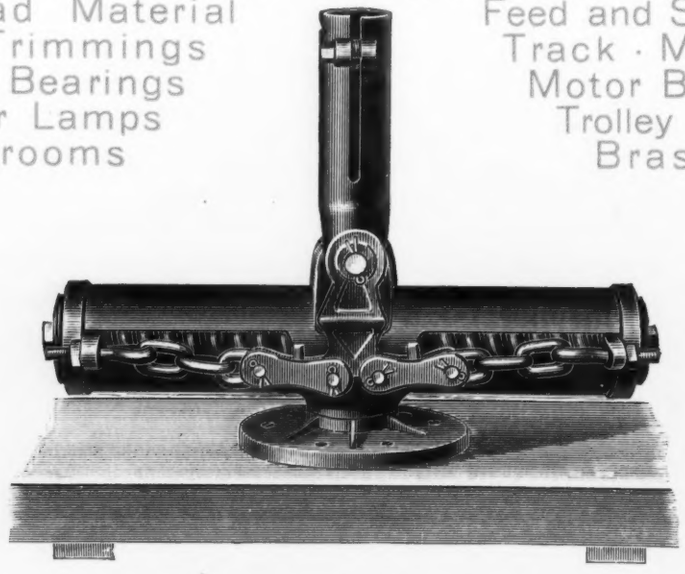

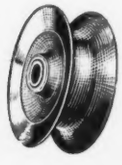

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ERRATA: On Page 113, Department "Hydraulics," the caption of Prof. L. M. Hoskins' article should read:

"Centrifugal Pumps and Hydraulic Principles," instead of:

"'Centrifugal Pumps' and Pneumatic Principles."

THE JOURNAL OF ELECTRICITY.

VOL. I. NOVEMBER, 1895. No. 5.

The Nevada County Power Transmission.

FIGURE 1.—*On the Slide.*

THAT the installation of electric power transmission plants in the mountainous mining regions of the Pacific Coast is attended with many unforseen difficulties other than electrical, is shown in the interesting plant now being erected in California by John Martin under contract for the Nevada County Electric Power Company. So typical is this undertaking of electric installations in mountainous countries, that a description of the means resorted to for handling the heavy machinery will be both interesting and instructive.

The plant under consideration is to be driven by water power, mainly derived from the south fork of the Yuba River, at a point 18,400 feet above the site of the power house. At this point a cribbed log dam, twenty-six feet high and seventy-eight feet wide, illustrated in Figure 4, has been erected. Inasmuch as the Yuba River at this point constitutes a torrential stream during the winter season, the utmost care was necessitated in the erection of a log dam to withstand the floods of each winter; accordingly a site walled in by solid granite was selected for the dam and the diverting flume shown in Figure 3 was built to carry off the water from the natural bed of the river, in order that each log might be bolted to bedrock and to each other. From the completed dam is run the flume shown in Figures 3, 4 and 5. This is five by six feet in size and has a capacity of 5,950 miners' inches. One and one-quarter million feet of pine lumber was used in its construction, which consumed the labor of 110 men for four months. Continuing, as the flume does, mainly along the granite bluffs confining the river, its construction was a task of great magnitude, involving the exercise of much engineering skill and risk of life on the part of the workingmen. The construction of the dam and flume was done under the supervision of Mr. Alf. Tregidgo, who from the outset has been foremost in the undertaking.

The flume terminates immediately above the power house on an exceedingly steep incline known as "The Slide," which, together with the power-house site, is illustrated in Figure 2, giving the water a head of 206 feet. From the penstock of the flume steel-riveted pipes, 320 feet in length, are to be carried down, the first 120 feet being of forty-eight-inch pipe, and the second and third 100 feet being forty-four and forty-two-inch pipe respectively. The pipe line terminates in the large steel receiver (Figure 8), which will supply water to the two sets of Pelton wheels operating the generators. This receiver is nineteen feet in length and forty-eight inches in diameter, weighs approximately four tons, and

FIGURE 2.—*The Slide and Power-House Site.*

constitutes the largest though not the heaviest piece of apparatus used.

As indicated, the power is derived from two sets of Pelton water wheels, each of which consists of two, thirty-four and one-half-inch Pelton wheels, direct con-

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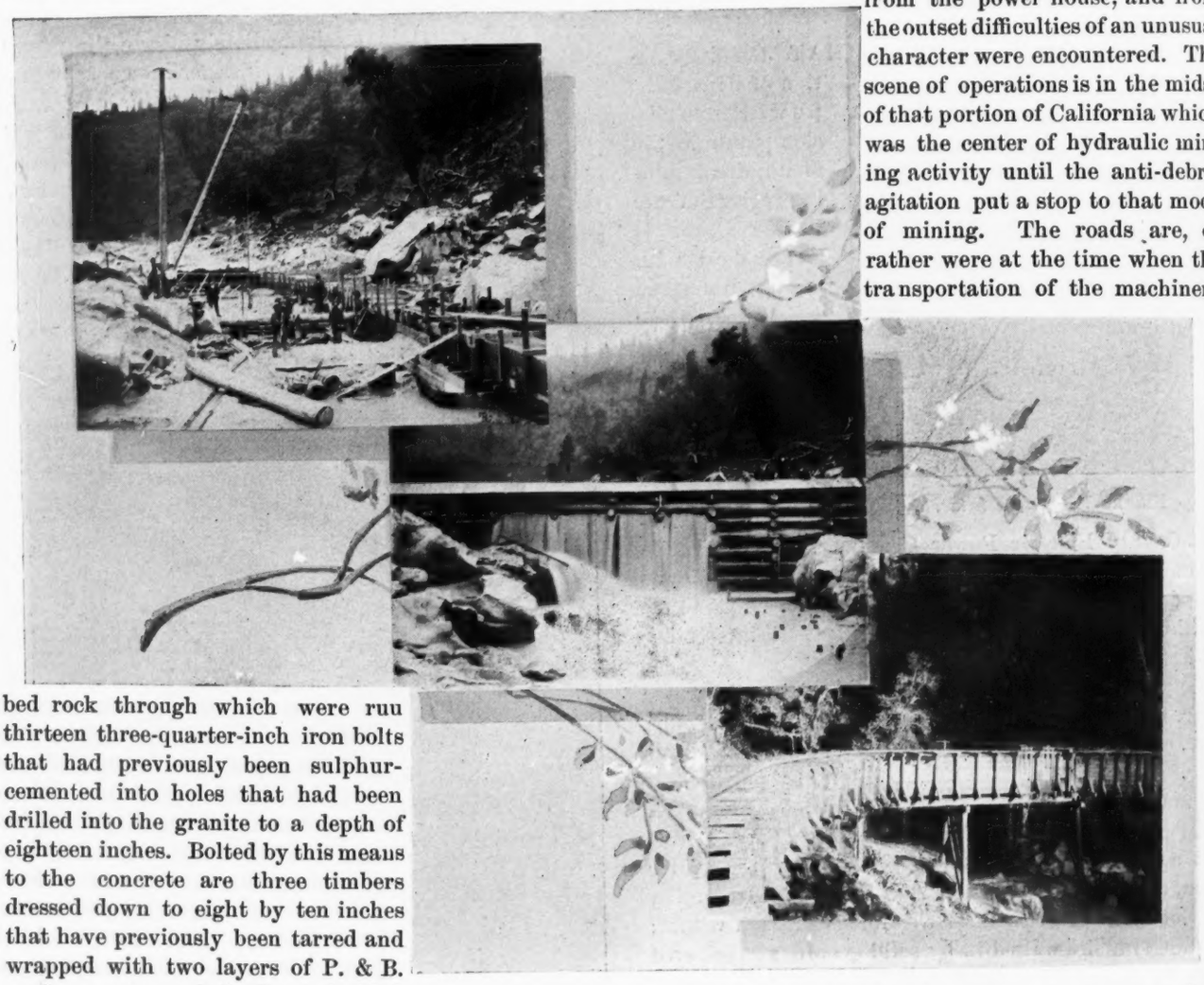
nected on the same shaft and each of which is driven by two three-inch jets. Regulation is to be effected by an improved type of the Pelton differential cut-off governor.

Direct coupled to each of these water wheels is a Stanley 500 horse-power, inductor type, two-phase generator, each of which is guaranteed under contract to have a commercial efficiency of 94.6 per cent., and an electrical efficiency of 98 per cent. The foundations of the power house are of the solid bed-rock granite, upon which the generator foundations are placed. These foundations consist of eighteen inches of concrete upon the bed rock through which were ruu thirteen three-quarter-inch iron bolts that had previously been sulphur-cemented into holes that had been drilled into the granite to a depth of eighteen inches. Bolted by this means to the concrete are three timbers dressed down to eight by ten inches that have previously been tarred and wrapped with two layers of P. & B. roofing paper and finally imbedded in cement. The holding-down bolts for the bed plates of the generators are lag screws, which in turn are sulphur-cemented into the wood timbers, thereby attaining the highest possible insulation resistance to earth. The generators will be provided with two Crocker-Wheeler multipolar exciters, each having a rating of five kilowatts. These are to be belt-driven by independent Pelton wheels, and either will be of ample capacity to excite both generators.

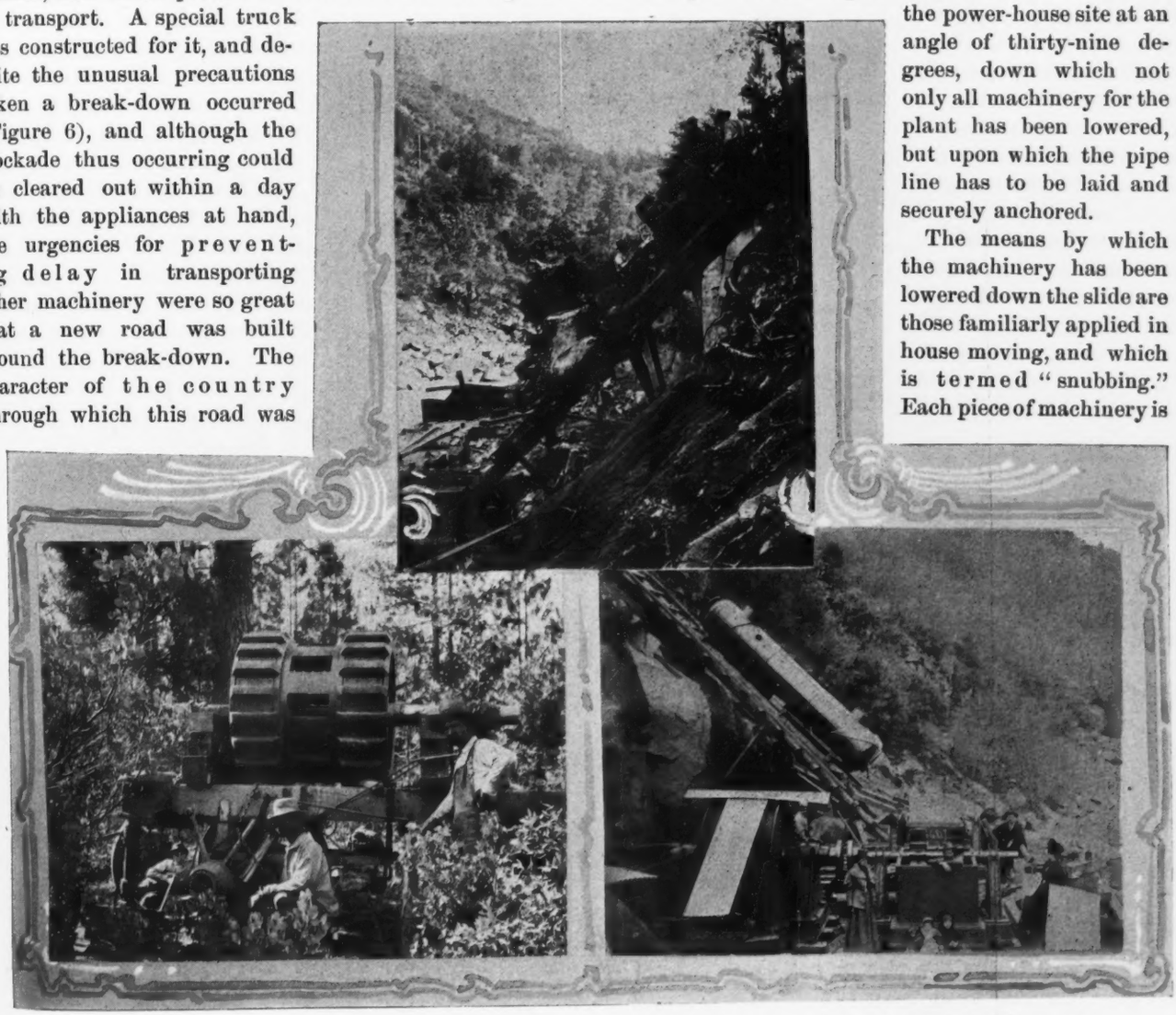


FIGURES 3, 4 AND 5.—*The Site of the Dam and Diverting Flume, the Completed Dam and a portion of the Flume Line, respectively, of the Nevada County Electric Power Company.*

No step-up transformers are to be used, as the generators will deliver two-phase current to the line at 5500 volts. The pole line is very close to eight miles in length and carries eight No. 3 B. & S. bare copper wires on two cross-arms, each pole being gained for two additional cross-arms. Thirty-feet round peeled poles are used, and throughout the entire line a sixty-foot clearance has been cut for the pole line through the timber and brush. The line loss is to be approximately 5 per cent., and the plant will be operated at 16,000 alternations per minute. Triple petticoat top-grooved porcelain insulators, five inches across the bell and manufactured by F. M. Locke of Victor, New York, are being used throughout.

The machinery for the plant was transported by rail to Nevada City, Cal., which is a little less than five miles from the power house, and from the outset difficulties of an unusual character were encountered. The scene of operations is in the midst of that portion of California which was the center of hydraulic mining activity until the anti-debris agitation put a stop to that mode of mining. The roads are, or rather were at the time when the transportation of the machinery was commenced, in practically the same condition as existed during the early mining days. They were exceedingly bad thoroughfares laid out over the shortest routes, almost regardless of grades. Whole mountain sides had been washed away by the hydraulic miners, and the rush and anxiety attendant upon the search for the precious metal forestalled all attempts at road-building, with the result that the highways were impassable for heavy machinery. The wagon road, such as it was, did not reach within nearly two miles of the site of the power house, which compelled the building of a

road over an exceedingly mountainous country, in addition to which the contractor found it necessary to partially reconstruct the old wagon road to the extent of clearing it of rocks and boulders, and widening it sufficiently to admit the passage of heavy machinery. This was drawn to the top of the slide by means of teams varying from six to twelve horses each, according to load. Each of the Stanley generators consists of six pieces weighing approximately five tons each, the heaviest piece being the inductor, which weighs 11,200 pounds, and which proved to be the most difficult piece to transport. A special truck was constructed for it, and despite the unusual precautions taken a break-down occurred (Figure 6), and although the blockade thus occurring could be cleared out within a day with the appliances at hand, the urgencies for preventing delay in transporting other machinery were so great that a new road was built around the break-down. The character of the country through which this road was constructed is clearly shown in the illustration and the growth of underbrush, cactus and small pine and scrub oak trees was so dense as to render road building a serious task. Many of the grades on this improvised highway were so steep as to necessitate lowering the trucks down by means of block and tackle, yet despite this the machinery reached its destination without having suffered the slightest injury.



FIGURES 6, 7 AND 8.—*Illustrating some difficulties encountered in the installation of the Transmission Plant of the Nevada County Electric Power Company.*

The greatest obstacles to be surmouted were those encountered in lowering the machinery down the mountain side, shown in Figure 2, in which the power-house site appears upon the river bank. In this illustration photography fails to bring out much more than a suggestion of the steepness of the slide. Within a horizontal distance of probably one-half a mile the mountain rises to an elevation of about 1700 feet above the river level. The first 400-feet drop from the top may be reached by wagon road. Continuing downward, the next 400 feet is an angle of twenty-five degrees, and the next 600 feet is an angle of thirty-two degrees. Then follows about eighty feet of thirty-five degree declivity, and finally a further drop of about 220 feet is made to the power-house site at an angle of thirty-nine degrees, down which not only all machinery for the plant has been lowered, but upon which the pipe line has to be laid and securely anchored.

The means by which the machinery has been lowered down the slide are those familiarly applied in house moving, and which is termed "snubbing." Each piece of machinery is mounted singly upon a heavy log sled made in the most substantial manner, and secured thereto by means of chains, ropes or in such other manner as will prevent slipping. Generally three 1½-inch manilla ropes are then secured to the sled and machinery, each such rope being wrapped several times around a tree trunk, and a man being stationed at each of the three trees to control the ropes. The load is then lowered gradually by slacking the ropes or "snubbing" them as in house moving.

The illustrations given convey a suggestion of the methods used in overcoming the barriers presented in

this interesting installation, and it is worthy of note that despite the many and unforeseen difficulties encountered the work of installation has progressed without mishap or delay, and the plant will without doubt be in operation by December 10th.

The mechanical features of the work have been placed under the direction of Mr. T. J. Benny, and the entire electrical equipment has been erected for Mr. Martin through the electrical engineership of Mr. E. E. Stark, of the Stanley Electric Manufacturing Company, whose apparatus is being used throughout.

The plant now being erected constitutes the initial installation, and it will therefore be enlarged as necessary to meet future demands. Probably seventy-five per cent. of the capacity of the plant will be absorbed in the delivery of power to the mining industries of the vicinity, and already sufficient business has been contracted for to more than defray all fixed charges.

Pneumatics.

AN ECONOMICAL AIR PLANT NOW BEING INSTALLED AT THE NORTH STAR MINE.

By Edward A. Rix, P. E.

The North Star Mining Company, of Grass Valley, Nevada County, California, has made a long stride ahead in the direction of economical power service, by installing upon their property a very complete system for the transmission and use of compressed air.

Figure 1.—*The North Star Air Transmission Plant. The largest tangential Water Wheel in the world, as it appeared before being housed in.*

It has been dawning upon the minds of power users that compressed air, which heretofore has been considered a luxury, can be bent to mine use quite economically and most conveniently. Much energy has been expended of late, also, by the advocates of compressed air, in disseminating information regarding the economy of air when it is used under proper conditions. Heretofore in California, with perhaps one exception, air has been used

cold in the engines or motors into which it has been introduced. Owing to the sudden and very considerable drop of temperature which occurs on the expansion of air in a motor cylinder, it is impossible to use it cold in engines of the expansion type, for it would take but a few moments to freeze up the lubricants and discontinue the operation of the machine. A gentle amount of heat, however, applied to the air before it is used in the motor, not only increases its volume to a marked extent — for instance, somewhat over forty per cent. upon heating to 350 degrees — but it supplies to the air a sufficient quantity of heat, so that when it is expanded in the motor cylinder, its exhaust temperature offers no inconvenience to proper working conditions. Air heated to this temperature can be expanded from its initial pressure down to the atmospheric pressure without any inconvenience whatever, and with most economic results.

speed of the machine is 440 feet, which, while not quite as economical as one somewhat lower, was dictated by the conditions under which the water-wheel operated.

The air enters the initial cylinder at the temperature of the power room, which is approximately 62 degrees, and is therein compressed to 25 pounds to the square inch gauge pressure. It leaves the cylinder at a temperature of 200°F., and passes through an inter-cooler of about 1000 running feet of one-inch copper tubes placed directly beneath the water wheel, and which receives from the wheel a continual shower of water at a temperature of about 58 degrees. This cools the air to such an extent that it is delivered to the high-pressure cylinders at a temperature of 60 degrees. In these cylinders the air is compressed to 90 pounds, and is delivered from the cylinders at a temperature of 204 degrees into six-inch mains which lead to the mine. Indicator cards taken

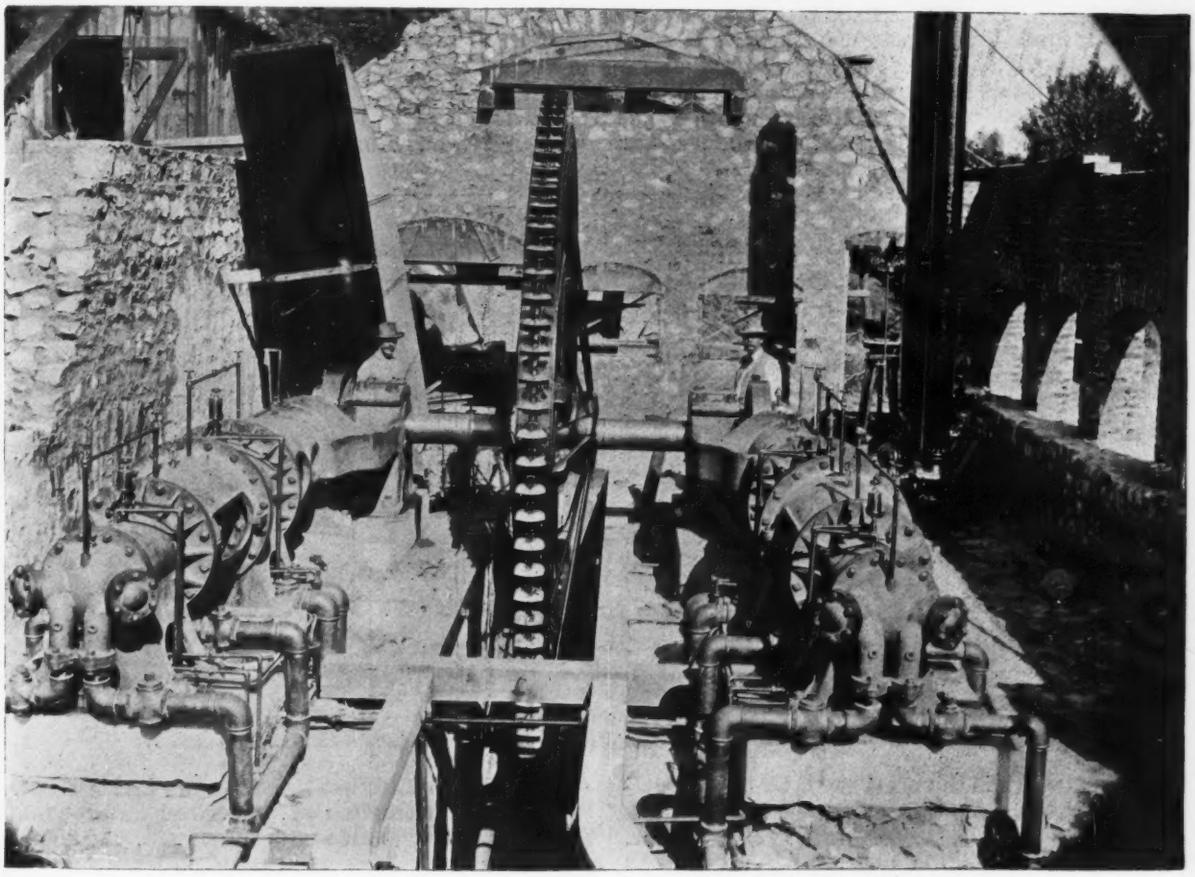


FIGURE 2.—*The North Star Air Transmission Plant. A general view of the Rix Duplex Air Compressors and Pelton Water Wheel, from a photograph taken during Installation.*

Realizing all this, after an extended investigation upon the subject, the North Star Mining Company, having a splendid water-power at its disposition, decided to install a very economical compressed air plant. A. De Wint Foote, M. Am. Soc. C. E., was placed in charge of the operations, and, after receiving bids from firms both in California and the East, the contract was placed with the Fulton Engineering and Ship-building Works, of San Francisco, for the compressed air plant, which concern placed the matter in the hands of the writer for execution. All the machinery was designed under his direction.

As shown by the half-tones accompanying this article, the compressors consist of duplex tandem compound machines. The initial cylinders are eighteen inches in diameter, and the high-pressure cylinders are ten inches in diameter by twenty-four inch stroke. The piston

from the cylinders show that the cylinders are doing equal work, and at 110 revolutions they work smoothly and perfectly.

Notwithstanding the fact that some builders claim that clearance has no detrimental effect upon the economy of their air compressors, in the Rix compressors the clearance is practically eliminated, being not to exceed 1-32d of an inch at each end of the stroke. The cards taken from these cylinders are perfectly square cornered.

The water-jacket system is quite unique, it being a duplex system — that is, there is an independent circulation for each end of the cylinder, the water passing longitudinally back and forth on the side of the cylinder and from the center in two independent streams, cooling the heads at the same time. The efficacy of this water jacket will be noted in the temperatures above given. The efficacy of the combined water jackets and inter-

cooler will be noted from the fact that in the single-stage machine, and at a pressure of 90 pounds, the final temperature of the air, if not cooled during compression, would be 459°F. In this machine the combined temperatures of delivery in the two cylinders is 404 degrees, the difference between these temperatures showing a very substantial gain in work, which otherwise would have to be lost.

In testing for volumetric efficiency, the receivers were carefully measured a number of times and found to contain 291 cubic feet. These were filled repeatedly, and the number of revolutions of the machine accurately counted each time. All of these experiments were conducted after the machine had been in operation for a sufficient length of time to reach its maximum temperature.

The barometer at the power house is 27.35 inches, corresponding to an elevation of about 2400 feet. This gives an atmospheric pressure of 13.32 pounds per square inch. At 90 pounds gauge pressure the ratio of compression would be 7.7, and the receiver containing 291 cubic feet represents 2240 cubic feet capacity of free air. The average of a great many experiments showed that the compressor took 102½ revolutions to fill the receiver from 25 pounds, which is the pressure of the initial cylinder, to 90 pounds. At this pressure of 25 pounds gauge, there is 830 cubic feet of free air in the receiver. The difference between these two capacities, or 1410 cubic feet, would represent the amount of air which was forced into the receiver at the revolutions stated. Inasmuch as the temperature of the receiver is somewhat higher than the temperature of the inlet air, there should be a deduction made from this sum corresponding to that temperature of about 2%, making the corrected amount delivered to the receiver 1382 cubic feet.

The theoretical capacity of the compressor, deducting the piston rods, and at 102½ revolutions, is 1429 cubic feet of free air per minute. The ratio between 1382 cubic feet, actually delivered, and 1429 cubic feet, theoretical capacity, is 96.6%, which represents the actual volumetric efficiency of the machine at the present writing. This, of course, will vary proportionately with the ratios of the absolute temperatures of the inlet air, depending upon the season of the year.

One peculiarity about the Rix compressor, as may be noted from the drawing, is the fact that the compressor is so arranged that any cylinder may be disconnected, or any end of any cylinder may be disconnected without interfering with the operation of the machine. This feature is very valuable in case of repairs or accident to the valves, any one of which may be removed and repaired, and replaced without stopping the machine.

To drive this compressor there has been placed upon the main shaft a Pelton water wheel, eighteen feet in diameter, which is believed to be the largest tangential water wheel ever made. This wheel is of peculiar construction, and was designed by Edward S. Cobb, M. E., of San Francisco. The head of water being 775 feet, and it being considered advisable to do away with all gearing, belting or ropes, it became quite a question to determine how to construct this wheel. In the first place, the piston speed of the compressor was placed as high as possible, 440 feet being considered about the limit that should be practically employed. This gave 110 revolutions for the compressor shaft. The most economical rim speed of the wheel, which is fifty per cent. of the spouting velocity, has placed the wheel at 18 feet diameter. Being operated at a peripheral speed of 6210 feet per minute, fears for its safety made the use of cast iron inadvisable, and even cast steel did not offer the necessary advantages. Mr. Cobb suggested the construction which is shown in the accompanying engravings, and the results have fully justified his calculations.

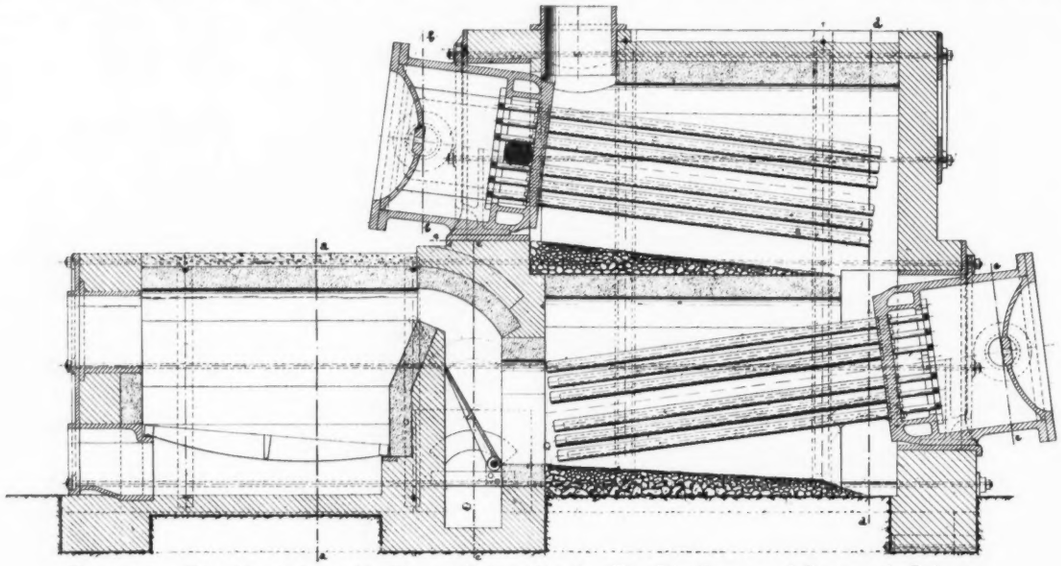


FIGURE 3.—*The North Star Air Transmission Plant. The Rix Compound Pneumatic Reheater.*

It will be noticed that there is a marked difference between the construction of this wheel and the ordinary bicycle wheel which it seems to suggest. In the bicycle wheel all spokes are in tension and are tangent to a circle concentric with the hub of the wheel, whereas in this wheel there are radial rods in tension to support the rim, and Mr. Cobb has introduced driving trusses to transmit torsional stress from rim to hub, all as shown in the outline view of wheel, Figure 4. The rim is of wrought iron, riveted up in convenient cross-sections, and the dimensions of the wheel are as follows:

Diameter over all	18	ft.
Width of face	8	in.
Diameter of shaft	10	"
Length of hub, bore	20	"
Length of hub over all	29	"
Center to center of spokes laterally at the hub	24	"
Center to center of truss rods at the hub	30	"
Diameter of radial spokes	1¼	"
Diameter of truss rods	2	"
Weight of rim	6,800	lbs.
Weight of spokes	1,500	"
Weight of hub	2,800	"
Weight of ninety-six Pelton buckets	672	"
Total weight of wheel	11,772	lbs.

The buckets are of bronze, being eight inches wide, and the cover being two and one-half inches deep. They

add eight inches to the diameter of the wheel, and after being milled are riveted upon the outer rim. In actual practice the wheel is splendidly balanced and runs perfectly true and is an entirely satisfactory method of construction. Running at its standard speed with the connecting rods off the wrist pins and suddenly shutting the water off, it will continue to run fourteen and one-half minutes before it comes to rest, showing a correct balance. Water is supplied to the wheel through about 8000 feet of twenty-inch riveted steel pipe, built by the Risdon Iron and Locomotive Works.

The wheel is governed by automatic devices, which keep it at a standard speed and stop it and start it according as the air pressure increases or falls below the standard pressure. The compressed air, after leaving the compressors, is conducted to the mine and delivered to the reservoirs above mentioned, from which it is taken into the Rix pneumatic reheater, a cut of which is shown herewith. It is here heated to 350 degrees Fah., and delivered to the initial cylinders of a compound direct-acting pneumatic hoist. In this cylinder the air is cut off at one-half and exhausted back to the compound compartment of the reheater, where this air, which is about twenty-five pounds pressure, is again heated to 350 degrees. From here it is conducted to the compound cylinder of the pneumatic hoist and expanded to atmosphere, at a temperature of about 160 degrees, the exhaust flume connecting with the dry room for the men.

The air is also conducted from the reheater to operate a Dow compound sinking pump, having a capacity of 600 gallons per minute, and still further down the mine for operating rock drills.

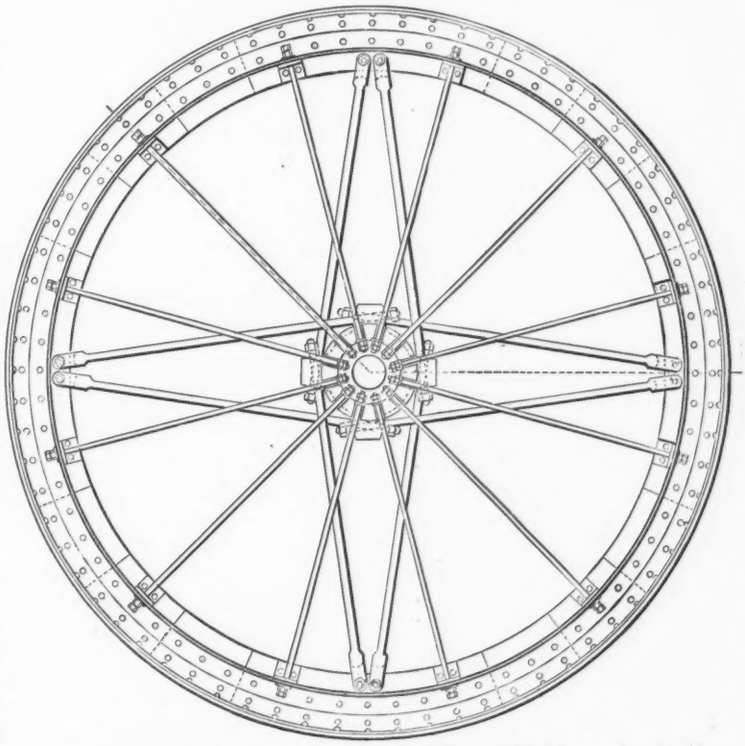


FIGURE 4.—*Outline Plan of the Pelton Water Wheel in use in the Air Transmission of the North Star Mine.*

The pneumatic hoist is not yet in operation, and will be the subject of a further description when it is completed. If the anticipations of the designers of this plant are realized, the pneumatic hoist will develop in its cylinders the indicated horse-power of the compressors at least, and possibly will exceed it. The entire economy of the system should exceed eighty per cent.

This plant is receiving a great deal of attention from the mine owners of the Pacific Coast who anticipate putting in power plants, and its successful operation will determine the installment of others of a similar kind. Nothing is being spared to make the North Star installation complete in every respect.

We would suggest that there is necessity for a change in the sub-title of our western contemporary, the "Pacific Electrician," which states that it is "the only electrical paper on the Pacific Coast." This is not accurate. Messrs. Perrine and Low's new paper, the "Journal of Electricity," is published in San Francisco and shows great signs of promise.—The Electrical Review, New York.

Hydraulics.

"CENTRIFUGAL PUMPS" AND PNEUMATIC PRINCIPLES.

By L. M. Hoskins.

All who are interested in hydraulic machinery will read the essay published by Mr. John Richards on the construction and operation of centrifugal pumps with profit, for the experience of Mr. Richards, as a mechanical engineer and designer of pumping machinery, enables him to give valuable information regarding the development and present condition of centrifugal pump construction, especially on the Pacific Coast. The work embraces two main points—a discussion of constructive features, and a historical sketch. An appendix contains brief discussions, by the author and others, of some interesting questions of theory and practice. No systematic discussion is given of the scientific principles underlying the design and operation of centrifugal pumps. In fact, it is stated at the outset that these pumps "defy the mathematician," and it is evidently the author's belief that theory is of little value in their design.

Under "constructive features" the following are the main points discussed: Size of impeller; form and dimensions of pump chambers; forms of impeller and of vanes; balancing of impeller against water pressure and against the weight of shafting and machinery; the question of double or single inlets; and the special requirements for dredging pumps. The question of attainable efficiencies is also touched upon, and the opinion expressed that for large pumps and for heads not exceeding twenty feet an efficiency of seventy per cent. should be realized.

After an instructive historical review of the centrifugal pump, it is pointed out, regarding its modern history, that the most noteworthy development is in the direction of high lifts. It is stated that these pumps have been successfully operated in California against heads as great as 160 feet. This fact is in striking contrast with the statements frequently found in works on hydraulics to the effect that the usefulness of centrifugal pumps is confined to low lifts.

It is not easy to understand why the theory of centrifugal pumps should present greater difficulties than that of reaction turbines. The hydraulic principles involved are identical in two cases, although, as our author says, the description of a centrifugal pump as an "inverted turbine" is quite inaccurate. It may be of interest to give here a brief statement of the main principles involved, and a comparison of the two classes of machines.

By "reaction" turbine is here meant one which operates with passages completely filled with water. The

term does not accurately describe the operation of such a turbine, but no better name seems to have been suggested. The main conditions to be observed for the efficient working of such a motor are: (1) The water should enter the wheel without shock; (2) the flow through the wheel should take place without sudden change of velocity; and (3) the absolute velocity of discharge from the wheel should be as small as possible. To satisfy these conditions, the direction of wheel-vanes at entrance and exit points, and the speed of rotation, must be properly adjusted to each other. As a general rule, it may be said that water should enter the wheel with an absolute velocity directed nearly tangentially forward, and should leave the wheel with a relative velocity directed nearly tangentially backward. This relalive velocity, compounded with the tangential velocity of the wheel at the point of outflow, should give as small a resultant as possible.

During the gradual deflection of the water in the wheel passages, energy is transmitted from the water to the wheel. What percentage of the energy lost by the water is thus utilized, and what percentage is carried off by the outflowing water, in the case of any given turbine working with a given head of water, depend upon the speed of rotation. If the speed is gradually increased, beginning at zero, the percentage of energy given to the wheel increases up to a certain maximum value, and then decreases; and for some values of the speed of rotation it becomes zero. If the speed is still further increased, the energy transferred to the wheel becomes negative, or, in other words, *the water receives energy from the wheel.* Now, if in this latter case the design of the wheel is such that the energy lost by dissipation into heat by friction, impact, etc., is not too great, the wheel will operate as a pump, aiding the flow. Thus, a centrifugal pump is not an "inverted" turbine, but rather a turbine running at too high a speed to operate as a motor.

In estimating the flow through a turbine and the energy taken from (or given to) the water for a given head and velocity of motion, the only principles needed are "Bernoulli's Theorem," giving the relation between velocity of flow, pressure and height, at all points of a stream in a condition of steady flow in fixed passages, and the analogous theorem for flow through rotating passages. These theorems need not be given here, but it is to be remarked that they apply equally whether the turbine operates as a pump or as a motor, and the problems of design should be as readily solvable in one case as in the other.

It is a well-known principle that, for a given turbine motor of the reaction type, the speed for highest efficiency varies as the square root of the head. Further, if the head changes, and the velocity of rotation changes as the square root of the head, the velocity of flow through the wheel (and therefore the quantity of water discharged) will vary in the same ratio as the speed of rotation. This is, perhaps, the most serious disadvantage of reaction motors. If the design is made for a certain fall and discharge, the wheel cannot yield its highest efficiency for a different fall, unless the supply of water changes correspondingly, and it cannot give its highest efficiency for a changed supply of water, unless the fall is correspondingly changed.

The same principle would seem to hold for turbine pumps. If a pump is designed so as to give a high efficiency when working at its best speed against a given head, any change in the head will cause a decrease of efficiency, unless the speed of rotation is changed in the ratio of the square root of the head, and if this is done, the discharge will vary in the same ratio. Thus, suppose a pump working against a head of 36 feet has its highest efficiency when making 300 revolutions per minute, if the head is decreased to 25 feet, the speed for best efficiency should decrease to 250 revolutions per minute, and the discharge would be only five-sixths as great as before. The given pump could not, therefore, raise as much water against a head of 25 feet as against 36 feet without a decreased efficiency. It is doubtful whether this principle is clearly understood by manufacturers.

The influence of the form of the impellus vanes upon the efficiency is one of the questions discussed in Mr. Richards' essay. The author seems to regard this as of minor importance, especially with low lifts. Theory indicates as desirable a curve of such form as to gradually deflect the water until its direction of flow near the outlet of the wheel becomes nearly tangential and opposite to the motion of the wheel. The object of this is to make the *absolute* velocity of exit as small as possible. This absolute velocity necessarily has a forward tangential component of considerable magnitude because of the rotation of the wheel, and this should be neutralized as completely as possible. The form of vanes is, doubtless, of less practical importance with low lifts than with high, because a much lower wheel velocity is needed to give the required presssure in the discharge chamber. Efficiency is often made a less important consideration than capacity.

The existence of a high velocity of outflow from the impeller passages would be of little detriment to the efficiency if it were possible to produce a sufficiently gradual transition from this velocity to that in the discharge pipe. This may doubtless be partly accomplished by the gradual enlargement of the passage leading from the impeller chamber to the discharge chamber. This feature is used in the design of Schabaver, of which an account is given in the appendix to Mr. Richards' book, and is said by the author to have been also devised by Mr. G. W. Price, of San Francisco. According to the description given, the method of Schabaver is to make the discharge chamber "a narrow orifice extending around the whole circumference of the casing," and gradually widening outwards, "so that the water arrives without shock in a spiral collector surrounding the pump and leading into the discharge pipe." This is identical in principal with Boyden's "diffuser," used for a like purpose with turbine motors. Francis, in his experiments with the Fremont turbine, found that the use of a diffuser gave an increase of 3 per cent. in the efficiency. (Lowell, Hydraulic Experiments, page 5.) Experiments seem to be wanting to show the value of this construction in the case of pumps.

It is probable that the efficiency suffers much greater diminution by frictional losses at high speeds than at low. This matter of frictional losses and other practical objections to extreme high speeds would seem to be the limiting condition for the working of pumps against high heads, since high rotational velocity is necessary to produce high pressure in the discharge chamber. It is doubtful whether this difficulty can be completely overcome except by compounding.

The plan of compounding two or more pumps in series has been employed with apparently complete success. From a theoretical stand-point, the compound pump seems to furnish a complete solution of the problem of efficient working against high heads. If two exactly similar pumps are used, each yielding a certain efficiency when working alone at a given velocity against a certain head, and if the discharge pipe of one is made the inlet pipe of the other, the two ought to work against a double head with undiminished efficiency; the best speed of rotation and quantity of discharge being the same as for each pump working alone against the original head.

The frictional loss of efficiency should be the same for the compound pump as for the single one working at the same speed and discharging the same quantity of water. Each pump, in fact, does the same quantity of work, whether acting alone or compounded with the other; the sole difference in the conditions of the two being that the pressure in every part of one is greater by a constant amount than that in the corresponding part of the other. There is no apparent reason why, by compounding any required number of pumps in the same way, water cannot be raised to great heights as efficiently as to moderate ones. The question of high lifts thus becomes one of economy of construction and maintenance rather than one of possible successful working. So far as first cost is concerned, Mr. Richards expresses the opinion that it is much less for a compound pump, such as he illustrates on page 59, than for piston pumps, to do the same work.

The matter of the balancing of impellers is of much interest, both theoretical and practical. The "hydraulic step," by which the pressure of water in rapid rotation is made to balance the weight of shafting or other loads, was invented by Professor F. G. Hesse, and is the subject of Bulletin No. 2 of the Department of Mechanical Engineering of the University of California. Space is wanting for a description of this interesting device or an account of its theory.

On the whole, the impression given by a careful reading of Mr. Richards' book is that designers in America, and especially on the Pacific Coast, have attained a high degree of success in the adaptation of turbine pumps to a variety of conditions. It seems probable, however, that still further advance may be made by the intelligent application of hydraulic principles.

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Palo Alto, Cal.

RESONANCE IN BOILER EXPLOSIONS.

By Lieut. W. Stuart-Smith, U. S. N.

Occasionally a boiler explodes under circumstances which make it exceedingly difficult to determine the cause. The evidence of those in whose charge the boiler is entrusted is to the effect that the steam pressure was not above the normal and water was carried at the proper height, so there could be no danger of explosion from overheated plates. An examination of the debris shows no evidence of overheating the metal of the shell, traces, etc., show good section, with no evidence of serious erosion, and a test shows the metal to be of good quality. With good metal of proper section and boiler well proportioned, it is manifest that rupture can only occur through excess of pressure, and the report of the examiners is that without doubt the fireman neglected his duty and allowed the pressure to reach a point which was beyond the strength of the metal to withstand.

In cases where the evidence in favor of the fireman proved to be so strong that no possible doubt could be expressed regarding the fact that the pressure was not excessive, and examination showed no defect in design or material, the necessity for an explanation brought forth theories to account for instantaneous development of enormous pressures. According to one of these, the water over the furnace crowns might exist in a spheroidal state—that is, be held out of contact with the plate by a layer of steam—in consequence of which the plate became highly heated, and the spheroidal state being broken, the water was brought into contact with the hot plate and flashed into steam, thus producing a sudden enormous pressure with a resulting explosion. The propounders of this theory did not realize that, owing to the large amount of heat rendered latent in evaporating a small quantity of water, the excess of heat in the plate would not be sufficient to evaporate any considerable quantity, even if such a spheroidal state, with consequent heating, would be possible with the rough plates and other conditions existing in a boiler.

Another theory that was much propounded was that water was decomposed by some electric action, andthat the resulting oxygen and hydrogen, existing as a highly explosive compound in the proportions necessary for formation of water, accumulating in considerable quantity, was in some manner ignited, with resulting enormous increase of pressure and explosion of boiler. Apparently no consideration was taken of the fact that even if oxygen and hydrogen were thus formed they would pass off with the steam, hydrogen especially, on account of its low specific gravity, being very quick to do so.

At present such theories are scoffed at, and the verdict is that the pressure was allowed to become too great — a faulty steam gauge or other cause preventing a careful fireman from being aware of the fact. Such verdicts, however, are sometimes rendered solely because the examiners realize that excessive pressure must be the cause, and, rejecting what they know are absurd notions, they find themselves confronted with the necessity of assigning a valid reason.

Still, mysterious explosions sometimes occur, and the writer believes they may be caused by a sudden increase of pressure, and offers the following explanation, which, while it may, to some, seem as absurd as the theories quoted, is founded on strictly scientific principles and represents a by no means impossible condition.

Resonance has long been studied in relation to sound, but it is only within recent times that the very important place it may occupy in cases where force is transmitted by means of vibrations in elastic media has been realized. In cases where steam and other vapors and gases are used as the media for the transmission of force, this transmission is not accomplished by means of vibrations in the elastic medium, but the medium itself is strained, and being transmitted in mass to the point where it is desired to have work performed, it is placed in conditions favorable to the release of the tension. During this recovery from the strained state, work is performed equal in amount to the energy which disappeared in producing the strained condition. It is only in the case of those substances, such as gases and vapors, which are elastic and mobile in the highest degree, and which can have their volumes varied through wide limits without altering this state, that practical use, for purpose of performing continuous work, can be made tendency to recover from a state of strain. Other substances, such as ivory, glass, etc., are highly elastic, but the limits through which they can be strained are too narrow to permit of their use in performing continuous work.

Vapors and gases, possessing the property of elasticity in such high degree, are not only capable of receiving enormous static strain, and in this state, being transferred from place to place, but they are capable of being strained by an impulse received at one point, and of recovering from this state of strain by transmitting it to neighboring portions of the mass, thereby setting up vibrations which gradually die out, owing to the want of perfect elasticity. This fact being recognized, it is possible to offer a theory which the writer believes furnishes a correct explanation of many mysterious boiler explosions, and incidentally accounts for some peculiar looking indicator diagrams which are usually set down as water in the cylinder, inertia of the moving parts of the indicator, etc.

The distributing valve of the engine being closed, steam fills boiler, steam pipe and valve chest, and has no

motion as a mass. The valve opens and permits steam to enter the cylinder, thereby giving motion to the mass of steam in the pipe, the velocity attained being, say, 100 feet to the second at the moment of cut-off. When cut-off occurs this motion is arrested at the steam chest owing to the rigidity of the metal, but along the body of the pipe no such impediment exists, and owing to its inertia the steam continues its forward movement, compressing the portion before it until the resistance to compression finally brings the mass to rest. When this occurs the steam at and near the engine will have a density considerably in excess of that near the boiler, and there will be the equivalent of an impulse producing strain at one point of an elastic medium. The result will be that the recovery from the strained condition will send a wave toward the other end of the pipe and the boiler, which wave will tend to travel back and forth through the pipe with continually decreasing amplitude. The same thing will occur at the following and all other admissions of steam to the cylinder, so that, in addition to the periodically interrupted forward motion of the steam as a mass, there will be a series of waves continually traveling backward and forward through the pipe. If the time of propagation of a wave from the engine to the far end of the pipe and return differs materially from the time elapsing between cut-offs in the engine, the mass of steam will be filled with a series of vibrations moving in both directions, and differing in phase to such an extent that there will be so much interference as practically to eliminate all vibrations, and instruments will make no record of them. If, however, the conditions are such that the first wave formed travels forward and returns just as the wave formed by the second cutting off is ready to start forward the two will add themselves together and a single wave of increased amplitude but same wave length will go forward, with result that, in addition to the steady strain on the pipe due to the pressure of the steam, it will be subjected to waves of strain which pass along it. This occurring for several consecutive revolutions of the engine, the amplitude of the wave will, by resonance, be raised to a very large figure, and a very great strain be brought to bear on the pipe. Such a wave passing into the boiler and then rebounding will subject it to a *sudden* increase of pressure, much in excess of that due to the steam, and will have its effect increased owing to the fact that it will be applied as a live load. A sudden enormous increase of pressure in a boiler may be thus explained on a strictly scientific principle.

The energy due to the forward movement of the steam at one cutting off may be readily calculated. Suppose there is a 10-inch steam pipe 100 feet long, steam pressure 125 pounds. At this pressure there are 3.549 cubic feet of steam per pound, or the total quantity of steam in the above pipe wlll be 15.36 pounds. With steam, at moment of cutting off moving 100 feet per second, the energy of the moving mass of steam will be 2385 foot pounds, which is the force which will compress the steam preparatory to the production of the first wave. In a very brief period, if the conditions are right for the production of resonance, this energy will be many times multiplied.

Such a condition of affairs is certainly possible, though it will occur only at rare intervals, and it is sufficient to account for some mysterious explosions. It is impossito guard against, owing to the variety of conditions which are influential in producing it. In order that the maximum effect may be produced it is necessary that the primary vibration period of the steam in the pipe should correspond with the times of cutting off steam in the cylinder, and there is usually sufficient variation in the speed of the engine to perhaps greatly promote interference; moreover, the vibration period of the steam is itself continually changing, as it depends upon the elasticity of the steam, which is a continually varying quantity, since it is affected by every variation in the pressure and by every variation in the amount of entrained moisture. It might happen that a steam plant would operate for many years without the proper condition for maximum resonance occurring; then the proper relation of steam pressure, entrained moisture and engine speed might occur, and in a few moments a disastrous explosion would take place, with absolutely nothing to show the reason why. Steam pipes as well as boilers will explode from this cause.

With regard to the engine indicator, it occasionally happens that an instrument which is in excellent condition and usually takes fine cards, is applied to an engine, and the cards show an admission line which rises far above the steam line, and even far above full boiler pressure. Sometimes this line falls back at once to steam line, and again it may enclose a small area before reaching this line. The expert thinks there is water in the cylinder, and, finding this is not the case, blames the indicator. There may in reality be water in the cylinder in some cases, and certainly indicators are sometimes to blame for such additions to the card, but it will be occasionally noted that some particular engine has a habit of showing such cards when the steam is dry and the indicator in good order. At times, even, there is a hump in the steam line between admission and cut-off. If our theory that resonance may cause, in the steam pipe, waves of considerable amplitude is correct, we have a possible explanation of some of these card peculiarities. If, as the valve was opening, or after it opened and before steam was cut off, a wave reached the steam chest it would record itself locally on the card as an increased pressure which would be called " water " if made on the admission line, and a curiosity if made on the steam line. Of course it could produce no effect after steam was cut off.

Where an engine persists in showing this peculiarity it seems probable that the conditions as to length of steam pipe, pressure carried, revolutions per minute, etc., are right for producing partial resonance, either with the main wave or one of the harmonics, and it would be well to so alter the condition as to break up this resonance in order to avert danger of explosion due to an accidental adjustment of conditions whereby more perfect resonance might occur.

BERKELEY, Cal., *Nov. 25, 1895.*

MULES FOR PASSENGERS.

The march of improvement has deprived the little city of Ontario, Cal., of the greatest novelty that that town afforded. Before the trolley made its advent, a solitary car used to wend its way, pulled up a slight incline between a beautiful avenue of trees several miles in length, the motive power being a pair of patient mules. When the end of the road was reached, a curious sort of flat car, looking not unlike an old-fashioned trundle bed, was pulled from under the passenger car and hooked behind. The two mules then mounted their flat car, the driver took his place at the brakes, and the trip commenced down the grade to the town, and of all who have taken this romantic ride, none have enjoyed it more than the mules themselves.

The popularity of a technical publication can best be determined by the demand for it, and in this connection it is interesting to note that it has been necessary to reprint two numbers of the " Journal of Electricity," namely, the August and September issues, to supply orders for back numbers.

The Journal of Electricity.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

EDITED BY

F. A. C. PERRINE, D. Sc., and GEO. P. LOW.

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EDITORIAL.

THE FAR WEST RECOGNIZED.

The recent appointment of a local secretary of the American Institute of Electrical Engineers for the Pacific Coast shows an important advance in the policy of the Institute as well as an encouraging sign of the character of the electrical engineering on the Pacific Coast. Heretofore the Institute has been charged, with more or less justice, with being a close corporation, run in the interests of certain members residing about the city of New York. The first successful broadening of the Institute policy was found in the establishment of local meetings in Chicago; but local meetings have been viewed with suspicion by certain of the New York members, and little encouragement has been given to the informal meetings of members at places where the membership was too small to warrant local meetings on the Institute plan. The informal meetings held in San Francisco during the past winter were of undoubted personal benefit to all members who attended, and they will, we hope, be the cause of bringing forth a greater number of papers written by those residing on the Pacific Coast. It is gratifying now to find that at last the efforts made toward impressing the necessity for greater recognition of the Pacific Coast members have been appreciated by the Council, and there is but little doubt that the confidence shown by the appointment of a local secretary will be amply justified.

COMPETITION IN THE TELEGRAPH.

While undoubtedly the recent decision of the Supreme Court, denying the right of the Pacific railroads to make an exclusive lease of their right of way to any one telegraph company, will have an important bearing on the telegraph service to points between San Francisco and Chicago, and possibly upon the general telegraph business of the Pacific Coast, it must not be supposed that the entire question of the competing telegraph line is settled by this decision of the courts. The courts may without a doubt compel the revocation of such exclusive leases, but it is hardly possible that they will undermine the present good will existing between the telegraph companies and the railroad. This good will of itself is in general of a greater value to the telegraph company than the simple question of right of way, since it is the custom of the railroad company, which acts in harmony with any particular telegraph company, to furnish a system of inspection to the telegraph company, through the medium of their track walkers, and to allow special facilities on their trains for the transportation of repair supplies and linemen. Where such courtesies are not extended, the simple right of way is of comparatively little value, indeed, of almost no more value than the right of way through the open country by the side of the railroad track, which at any time might have been secured. These complicated conditions are not often considered by the general public, in rejoicing over a court decision similar to that we have chronicled, whereas, to the practical engineer, the points now covered are of more importance than those upon which the courts may render their decisions.

ELECTRIC VS. "COAL CAR" TRANSMISSION.

It is with interest that we note that an effort will be made to transmit electrical energy from the mines of Corral Hollow to Stockton, San Jose and other cities, and even with greater interest do we hear that the power derived is to be applied to the operation of an electric railroad thirty-two miles in length, extending from Livermore to Oakland. Proposals similar to this have been made in England, and for a transmission of energy from the Pennsylvania coal fields to certain of the neighboring Eastern cities, although the application of power to railroading is a proposal which adds a new element, opening new possibilities to the plan. The possible financial economy of the scheme depends upon whether it would be cheaper to transmit the energy of the coal over an electrical line than it would be to carry the coal itself by railway or steamer to the point of consumption. In the one case an excess of electrica energy must be developed, which is utilized in the transmission of the electricity itself; in the second case, a proportion of the coal itself must be burned to effect the transportation. In carrying the coal bodily, account must be taken of the maintenance of the railway necessary for its transportation, whereas in the transmission of power by the means of electricity is had a cheaper line to maintain, although, perhaps, a greater amount of the total energy of the coal must be utilized in the transmission. The calculations made by English engineers have indicated that the electrical transmission of energy of the coal is probably the cheapest manner in which a definite amount of coal can be used, and when we consider the fact that freight rates are much lower throughout England than in California, it seems that we may be able to predict a very considerable financial saving to the users of the electrically transmitted power, as well as a profitable undertaking to the owners and promoters of the electrical enterprise.

LIGHT HAULAGE BY MEANS OF ELECTRIC MOTORS.

The question of light haulage by the means of electric motors has attracted much attention since the early attempt of the late Prof. Fleming Jenkin to establish in England an automatic overhead hauling system which he named Telepherage. Little success attended the various efforts to establish telepherage lines on account of the fact that the overhead line construction to support motors sufficiently heavy for the necessary tractive effect was too expensive when compared with tram lines laid upon the ground, although the construction necessary simply to carry the loads to be moved might in some cases be cheaper than tram lines. The Boynton bicycle railway is one that possibly reduces the cost of construction when compared with the other systems of elevated railways, but it can hardly be possible that any such rigid overhead construction would be as economical as a surface road.

These difficulties have been met by Mr. Richard Lamb in his system now being installed along the banks of the Erie Canal, and already in successful operation for the haulage of logs in the Dismal Swamp of Virginia. The system consists of a pair of standing ropes suspended from a stout pole line construction, the upper cable carrying the weight of the motor and its load, while the lower cable is proportioned simply to afford tractive effect by means of passing it several times around a sheave attached to the locomotive motor. The current is carried by the bearing rope, and returned to ground through the traction rope. Undoubtedly, less power will be used by this system than that which is necessary in the commoner systems of cableways with running traction ropes, and a wide application might be predicted for such a system in the hauling of light loads over moderate distances.

The important proposition of this haulage system, however, is one that looks towards the re-establishment of artificial inland waterways that have so largely been superseded by steam roads. No doubt the Lamb system is a system well adapted to boat towage, but its success as a means of haulage does not by any means establish the efficiency of artificial inland waterways. In the case of the Erie Canal, fifty-one millions of dollars have already been expended upon its construction, and it is stated at the present time that nine millions further must be spent before the canal can be operated at a maximum efficiency. Mr. Frank W. Hawley, who has the contract for applying electric haulage to this canal, anticipates that its introduction will warrant the use of about three thousand boats carrying two hundred and sixty tons each on the canal, which would mean that as many as ten boats to the mile would be towed. These boats, as recently built, have cost fifty-five hundred dollars each, and when we consider that at least fifteen central stations, having an aggregate capacity of not less than thirty thousand horse-power will be required to furnish the power, it is at once seen that the interest on the cost of the investment necessary to apply the system to the Erie Canal in an efficient manner would bring the cost of transportation of goods from Buffalo to Albany up to a figure which would be little if any below the charges now made by the steam roads, and it is hard to see how the simple applicability of any such haulage system by the means of electrical power would warrant the great outlay necessary for building and maintaining an expensive system of artificial inland waterways such as are proposed from time to time by the daily press in its campaign against the alleged extortionate freight rates.

AN INACCURATE ESTIMATE OF POWER TRANSMISSION.

It is surprising that a journal as carefully edited as the Engineering Magazine should print an article so full of inaccuracies as that of Alton D. Adams on the "Limits of Electrical Power Transmission," which purports to show that the annual fixed charges on an electrical transmission line twenty-five miles long will amount to $22.83 per horse-power hour, as against a cost of $25.00 per hour for steam power, coal costing between $2 and $3 per ton. If the statements in this paper could be established, there certainly could be no possible economical distribution of power from a water-fall or other source greater than fifteen to twenty miles; but when we analyze the items of cost given by Mr. Adams, which pretend to be the lowest possible figures, we find that he makes the statement that 4794 horse-power of electrical machinery at $20 per horse power are required in the transmission and delivery of 1000 horse-power, the total amount of power being composed of 1520 horse-power in generators, 1000 horse-power in motors and 2397 horse-power in transformers, omitting altogether the consideration of the fact that the Stanley Electric Company transmits power at 10,000 volts without the intervention of transformers. We are astonished to see that Mr. Adams rates such generators and transformers as high as $20 per horse-power, whereas during the last year generating machinery has been sold on the coast as low as $11.00 per horse-power in cases where not more than 500 horse-power were purchased, and the figures that he gives are higher than the price for 600-light dynamos in the city of Boston four years ago. Besides this misstatement, Mr. Adams has included in his estimate for wire the amount necessary to transmit 1000 horse-power 100 miles, in place of 25 miles, which is the assumed condition of his problem. Making these corrections in his figures, we find that his total cost of installation is to be divided by at least two, and in place of almost $23 per hour for transmission cost, not more than $10 or $12 should be allowed.

Transmissions approximating the distances he attempts to prove impossible have, unfortunately for Mr. Adams's figures, already proved themselves to be economical, and such inaccurate statements will do little to advance rational transmissions or to guard against those which are irrational.

Passing Comment.

AN EDITORIAL REVIEW OF CURRENT EVENTS AND PUBLICATIONS OF OUR CONTEMPORARIES.

The question of the rating and behavior of fuse wires has at last been adequately treated in a paper read by Prof. W. M. Stein before the American Institute of Electrical Engineers. The minimum currents required to fuse such wires has been accurately ascertained in the experiments of Preece. The experiments of Harrington show the great currents they will carry on short circuits, and although it has heretofore been understood that time is a factor in the current necessary for fusion, the particular value of this time factor has not been clearly shown experimentally. These experiments have probably established the most accurate methods of fuse testing, and we fortunately are now able to predict the action of fuse wires under various currents, applied either rapidly or slowly.

In the Electrical Engineer for October 16th a leading article calls attention to the practical installation of electric launches as pleasure craft on a large park lake, and to those who have had the pleasure of riding on these launches at the Chicago Fair it is not surprising that such installations should be found remunerative.

While it may be possible that the weight of the cells is a disadvantage in tramway work, and that the constant jarring will disintegrate the plates, there is no doubt but that they are acting under ideal conditions when applied to boats, and there can hardly be a system conceived more directly applicable to their needs than in electric roads which are continually striving to increase their earnings by the establishment of parks and excursion parties. The current for charging is at hand wherever cars run, and the rates of fare are much higher than can be charged for any equivalent amount of land haulage.

One of the most important papers before the Montreal convention of the American Street Railway Association was read by N. W. L. Brown on the preservation of ties and poles by means of creosoting. Iron poles, though strong, have not given the life that was at first hoped from their use. Such materials as redwood and cedar are too weak to stand the great strains applied to trolley suspenders, while the life of the stronger woods is found to be very limited.

Creosoting has obtained an unmerited position of disfavor on account of the imperfect manner in which this operation has often been performed, but Mr. Brown's tests prove that where the work is thoroughly done the life both of poles and ties are so far increased that the operation is one effecting a great economy when all the items of annual expense are included. This subject is well worthy of consideration on the Pacific Coast particularly, as the long, dry summer effectually seasons the timber and greatly reduces the cost of creosoting as compared with localities where wet timber must be treated.

The question of transfers on our street railway systems has been so throughly discussed in the daily papers from the standpoint of the passenger, that one would almost imagine there were no disadvantages connected with the transfers to the railway management. Should such disadvantages consist simply of the decreased service for a single fare from individual passengers, the argument against their extensive use might be invalid, but to any one who holds this opinion there would be great enlightenment on reading the article by J. A. Cahoon, on the "Use and Abuse of Transfers," in the Electrical World of October 18th, where it is shown that the principal loss to the railway companies comes not so much from their legitimate use by the passengers as from their illegitimate use by the conductors and motormen, largely increasing the stealing from the company. We venture to assert that rarely does a street railway company wish to curtail its traffic or to inconvenience its passengers, but until some system of transfers be adopted which will avoid their being exchanged from one conductor to another, much sympathy must be felt for any railway company desiring to curtail their use.

The exact measurement of voltage, current and resistance by means of potentiometers is treated in an article in the Electrical World of October 12th, by W. M. Stein, of Chicago, in which he calls attention to the inaccuracies often creeping into the application of the potentiometer method of measuring current. This method is one that is so easily applied with a simple sensitive galvanometer, a standard cell and a couple of high resistances, that it admits the exact measurement of large currents for testing purposes where a high-reading galvanometer or ammeter are not at hand, and the method of using it should be thoroughly understood by all engineers. An imperfect understanding, however, will easily lead to exceedingly inaccurate results, and the principles involved, while simple, have been misstated even to the extent of omitting the instructions necessary for connecting to eliminate the internal resistance of the standard cell and galvanometer.

The method consists simply in passing the current to be measured through a large German silver resistance, the value of which is known; at the ends of this resistance a series of high resistances are connected in parallel with it, and the terminals of the standard cell connected through the galvanometer in such a sense that the e. m. f. of the standard cell will be opposed to the fall of potential from one end to the other of the high resistance. When the connection of the standard cell to the high resistance is so adjusted that there is no deflection of the galvanometer, then the e. m. f. between the terminals of the standard resistance is obtained by the relation of the total resistance between its terminals to the resistance of that portion which equals the e. m. f. of the standard cell.

Following the recent meeting of the Street Railway Association in Montreal, considerable amount of space has been devoted by all of the electrical papers to the subject of the most efficient brake for trolley tramroads. The speeds employed in these roads have continually increased from six or eight miles an hour to fifteen or twenty, and, even in some cases where considerable distances are to be covered in suburban districts, speeds exceeding thirty miles an hour are employed. When we consider the great momentum of a car weighing from fifteen to twenty tons running at such speeds, we can at once realize not only the difficulty but the importance of an efficient brake system. For ordinary stops the efficiency of the brake does not become of so great importance as it does when an emergency stop is to be made. Cable roads are all provided with an emergency brake, consisting of a solid shoe which may be pressed against the track hard enough to lift the car free from its wheels should extreme rapidity in braking be necessary, but where such brakes have been applied to cars not held to the track, as is the case with the cable car, by means of the grip attached to the cable, this emergency brake has been found likely to derail the car, and, in consequence, such a method may not be employed. The two methods of emergency braking, which seem to have been met with the greatest favor, are the air brake and the Sperry electric brake. Up to the present time, the disadvantage

of the electric brake has been found to be due to the fact that it requires the car motor to be rapidly transformed into a generator, and, where the commutator contact on the motor is dirty by long service, it will generally refuse to build up its own field and generate the current, while the air brake requires considerable extra weight for the brake mechanism, and depends upon a reservoir which may fail when the car is running slowly through a crowded district requiring frequent stops. It certainly seems that the electric brake is capable of giving much more efficiency than can be obtained by the means of an air-brake, but until one or the other of these systems has attained a greater perfection than is apparent up to the present, the running of high speed trolley cars must be considered as attended with a very appreciable amount of danger to foot passengers crossing the tracks.

The discussion which has followed Professor Forbes' publication of his view concerning the engineering contest in the Niagara transmission, has led to some adverse criticism of Lord Kelvin's preference for direct current power transmission, and many eminent authorities, led, perhaps, by Professor S. P. Thompson, have laid particular stress upon the adaptability of alternate currents to many various uses. It is stated by these advocates of alternate current transmission that no other system can be so easily manipulated and adapted to the many purposes of arc and incandescent lighting, long distance transmission of power, the transformation into any required voltage, and the regulation by the means of controllers, requiring but a small expenditure of energy; but these engineers have not taken the pains to call general attention to the fact, that, though an alternating current may be easily adapted to such uses, it is not by any means true that the same alternating current is applicable in every case. In order to install incandescent lamps with the maximum economy as regards first cost of lines and transformers, it is necessary that a current with a high number of alternations be employed, for efficient arc lamps to operate without annoying, noisy vibrations, a periodicity much less must be used, while the proper regulation of such lamps by impedence coils demands a current of high periodicity. Again, motors and rotary transformers are only to be considered as acting under ideal conditions whenever the periodicity is so low that the current approaches almost a pair of continuous currents in its character. The only engineer who has appreciated this problem sufficiently to attack its solution seems to have been Professor Rowland, to whom a late patent has been granted for a device capable of changing an alternating current of any number of phases or periodicity into one of any other number of phases, or other periodicity, varying the transformation of an alternating current all the way from a continuous current to a high periodicity multiphase current. As this invention has been explained up to the present time, it presents formidable complications, which seem to leave for the alternating current but small maintenance advantages above the continuous current system, which it seeks to replace, and to be very little if any better than the continuous current transmission operating motor transformers.

The great powers, which are available in coal mines and water-falls, are already being looked at with some suspicion by competent engineers, on account of their remoteness from the manufacturing centers. Although there is no doubt that the limit of twenty-five miles, which has been set by a writer in the Engineering Magazine, which we notice elsewhere, is entirely too small a limit, still the investigations of our best engineers, who have attempted the solution of long distance problems, show that the limit of economical transmission with machinery operating at 15,000 volts is not far from fifty miles where alternating current machinery is employed; that direct current machinery will extend this limit is difficult to predict, though it seems that many cases might be found in which the greater adaptability of direct current machinery to the many uses for which it might be employed would prove to be a greater financial success until the difficulties of manipulating alternating currents, as above indicated, have been more perfectly solved.

Literature.

ELECTRICAL ENGINEERING, LEAFLETS, in three grades, Elementary, Intermediate and Advanced, by Prof. EDWIN J. HOUSTON, Ph. D., and A. E. KENNELLY, F. R. A. S., 8-vo, cloth, 300 pp. Price for each course, $3.00. The Electrical Engineer, New York, 1895.

It is gratifying to notice that the desire for information concerning the principles of electrical science has become sufficient to warrant the production of many courses of instruction from the pens of the most distinguished and competent engineers. Among the many books published during the past few years with the aim of supplying this need, we have noticed none by authors more competent of speaking to practical men than these three volumes, which have been divided into grades, as best suited to the needs—first, of artisans with little or no knowledge of mathematics; secondly, to the understanding of those having an elementary knowledge of mathematics, and thirdly, to the needs of students pursuing a more advanced course under the direction of a competent instructor.

The value of the study to the student in any such course depends upon the exactness and thoroughness with which the elementary principles are explained rather than upon the newness of the apparatus described, and can never in any published book be entirely in harmony with the most recent practice, on account of the ever-changing nature of recent applications. Of these three sets of leaflets, the greatest importance is attached to the elementary grade, for the reason that so little which is accurate has been written that has been adapted to the understanding of electrical artisans and others with little or no previous knowledge of the subject.

It is a question whether the advanced course does not include more than can thoroughly be taught to university students in Electrical Engineering without an extension which would divide the subject matter of these leaflets into two or three separate courses of instruction; though for mechanical engineers and others whose time is largely devoted to collateral branches, an elementary knowledge of the principles and application of electricity is here given most clearly and concisely.

Turning our attention now to the leaflets of the Elementary grade, and viewing them from the standpoint of those for whom they are designed, we should expect to find sufficient information therein to enable a man who has completed their perusal to understand the conversations and the simpler descriptive writing of the ordinary electrical engineer, and we should demand that the information should be exact, as far as the student is carried. It is with much pleasure that we find here that this aim has been mainly well carried out, and that withal the writing is so phrased as to be easily understandable. But we must presume that there is a good amount of intelligence and earnestness possessed by any man who would take the trouble to follow this course voluntarily. If this is so, it seems to us to be a pity that our authors have begun by confusing the terms "energy" and "work," in the first chapter, though each term is correctly used in

the body of the book. Again, we notice that the explation of the term "potential" has been altogether omitted, though its elementary explanation can certainly be made simple, even though a complete understanding of "potential" may be difficult, and this omission is the more unfortunate since it is hardly possible for any one to understand what is said by engineers without its use. Besides this, the term "potential," when understood, explains more perfectly the character of the volt as a unit, and brings it more nearly to the comprehension of those who are accustomed to use the common mechanical units in the measurement of concrete quantities. Exactly why such a unit as the watt is omitted from the definitions, when the more complicated magnetic units are introduced, is hard to explain, especially as the authors use the unit by name in the body of their own text.

In the discussion of magnetism one would criticise the introduction of the term "magnetic flux," and its confusion with the lines of direction in a magnetic field; these terms are altogether distinct, and it seems that a great confusion may be produced in the minds of practical men which will be hard to eradicate.

On the whole, however, these points which have been criticised are not of great importance when we observe that the general tenor of the book is exact, and that its careful perusal will give a good understanding of the principles of the science, and will lay a firm foundation for further study. If the perusal of this first volume will lead any man to continue his studies into the second or intermediate grade of leaflets, the omissions we have noticed are largely supplied, and a course through the two books is the best and most practical that we have yet seen.

In no one of the three volumes is the true theory of the glass line insulator explained, and the province of the petticoat is not mentioned. Many constructors are prone to consider only the insulating property of the glass without reference to surface conduction, which leads too often to insulators being installed upside down as well as to the use of porcelain knobs out of doors, which would point to the importance of a more thorough discussion of the action of line insulators in such a course of instruction.

Much has been written at many times, especially in books treating primarily of physics, which refers so imperfectly to theories of electrical action that the elementary student is confused in his more advanced studies, and it is with great gratification that we notice in none of these leaflets matter which must be unlearned before an advance can be made. The three courses are well adapted to the needs of those for whom they are designed, and, though each is complete in itself, yet, as already stated, a great amount of benefit may be derived in considering the first two sets as a continued course, and in pursuing the third under the direction of an instructor.

THE ELECTRICAL TRANSMISSION OF ENERGY, by ARTHUR VAUGHAN ABBOTT, C. E., New York, D. Van Nostrand Company; pp. 586, 8-vo. Price, $4.50.

We have already published a preliminary notice of this manual of electric line construction, written by Mr. Abbott, the chief engineer of the Chicago Telegraph Company, and under whose supervision some of the best transmission lines in the United States have been constructed. It is not often that an engineer so well qualified has the inclination, and finds the time for giving the results of his mature deliberations to the general public through the medium of a book, but when it is our good fortune to obtain such a work, we find with the liveliest sense of satisfaction that the instructions given are all of an authoritative character, and that they will repay the closest perusal.

Naturally the section of this book on the construction of aerial lines, occupying three chapters, is the most valuable and complete, since these circuits are the ones most carefully studied by the telephone engineer. The lines of the American Bell Telephone Company throughout the country are undoubtedly the best constructed of any system of transmission lines, and, although Mr. Abbott gives us complete information concerning the general subject of line guying, and the construction of poles for carrying great loads, and for standing the excessive strains applied to anchor poles, we search in vain for the consideration which has led the telephone company to adopt their system of construction, which includes extra braces for cross arms, and a complicated system of guying in the direction of the line itself, in addition to the very complete system of side guys employed. The section devoted to the construction of electric railway circuits is more complete, including as it does the return circuit with an extensive discussion of the rail bonding question and electrolysis. Throughout the book there are a great number of different tables, some of which have been calculated by the author from well-established data, while others represent experimental results obtained by various investigators, and while there is no doubt of the usefulness of these tables and their general reliability, it seems unfortunate that in so few cases are the authorities for the tables given, which leaves the reader in consequent doubt as to whether the tables are due to the author's own investigations, or to those of others working in the same line. This is particularly unfortunate when we find that in some cases doubtful constants have been used, such as the conductivities in tables Nos. 3 and 7, where undoubtedly the published reports of manufacturing companies have been accepted as accurate without sufficient justification.

In his discussion of wire gauge he states that the Brown and Sharp gauge has been accepted as the standard for this country, but at the same time his tables for iron wire refer to the Imperial Standard gauge, which, so far as we are aware, has not been used to any extent by either our manufacturers or constructors. Some of the tables are also presented without accurate data or formula for their verification or extension, which is in many cases decidedly important, as, for instance, the table on page 453, purporting to give the areas given, covered by multiple wire systems, conforms neither to the indefinite formula which is given, from which it is supposed to have been computed, nor to any one of the well-established methods of obtaining the results given. Again, we find in table No. 55 the statements of the relative amounts of conducting material required in various conducting systems where continuous and multiphase alternating systems are employed, but no method is given by which the table may be verified, or by which the engineer can obtain for himself the size of conductors necessary to carry a definite current on the multiphase systems. Where curves and tables of cost are furnished, we notice that they refer more particularly to European practice, and, in consequence, the data given is of comparatively little value to American engineers, especially as no general method is indicated whereby the tables may be corrected in order to conform with our practice.

The same criticism that the book conforms more nearly to English practice than that which is in vogue in this country may be applied to the chapter on underground lines. An explanation of this may be, perhaps, found in the statement made in the preface of the book that the object aimed at is to make the statements throughout correspond more nearly to the future direction of practice than to a historical exposition of what has been done, but where so important a matter as the construc-

tion of underground conduits is to be undertaken, the engineer would hardly be justified in following the lines laid down as typifying European practice in the Crompton, Calender-Weber and other such systems, without the aid of a more definite expression of opinion and the results of experience than are given in this book, especially since the descriptions seem to have been taken from the publication called "Practical Electrical Engineering," rather than described from personal observation.

Two long chapters are devoted to a description of instruments, and to an exposition of the practical methods of electrical measurement, while the only reason that can be discerned for their insertion is that the methods explained conform more nearly to engineering practice than to those of the laboratory; and, although there can be no doubt but that there is a need for such treatment of this subject, it is to be very much questioned whether the exposition occurs properly in this book, since the presence of these chapters must have added to the cost of publication, and the matter published is less than is required by the engineer in all of his every-day measurements. It seems to us that it would have been much better if this section had been reserved for a more complete treatment in a separate treatise, especially as the subject matter given by Abbott has already been presented by Park Benjamin in his book on the Voltaic cell.

We have already alluded to the lack of information necessary to calculate alternate current lines, and this lack is more apparent when we find that a chapter has been devoted to the expression of the theory of alternate currents following closely the lines of Bedell and Crehore, but not advancing in any particular way beyond the theoretical elements laid down by those authors. The same matter might have been explained much more intelligently had the method of Steinmetz's Graphical Analysis been followed, which would have allowed its extension to practical calculations. The section devoted to the calculation of lines for both series and parallel distribution is the most complete that has been given in any American book, but the method of the author in the work already noted, "Practical Electrical Engineering," has been closely followed without any marked extensions of the methods and results there given, except in the case where the treatment of the calculation for the most economical conductor in any given transmission is furnished. While following closely the lines laid down by the English author, he has succeeded in giving an intelligible exposition of the subject, which was decidedly lacking in the English treatise. The methods explained for the calculations of mains and feed wires in any system follow closely those explained in the work above mentioned, and it seems surprising that Mr. Abbott has not distinguished between circuits when lights are all on or all off at one time, and circuits on which the lights are altogether independent, especially since the distinction between these cases has been carefully made by Carl Hering in his book, the "Wiring Computer." One is compelled to feel on reading this book that while undoubtedly an authority on certain subjects, Mr. Abbott has presented to us a great deal of undigested matter, and has limited his discussion of the subjects with which he is thoroughly conversant on account of lack of space.

Handling a Heavy Cable.

As we have already said, the subject of aerial lines has been thoroughly and well treated so far as the treatment goes, and that the subject of electric railroad circuits has been well covered, and that, although the careful collection of matter contained in this book is an exceedingly valuable thing to all engineers, we feel disposed to express disappointment that one who is so competent an authority has not given a fuller expression of opinion on those subjects covered by his experience.

THE ELECTROLYSIS OF ORES.

The electrolytic separation of metals from their ores is accomplished by first reducing the crude ore chemically to salts capable of being electrolyzed. Different salts of the same metal, treated by different methods, yield to electrolysis with different degrees of facility, and produce the metal with varying degrees of purity, and in variable quantity with the same current. On the nature of the preliminary process, therefore, depends the success or failure of the results. Among the various ores reduced in this manner are zinc, lead, copper, silver, gold, aluminum, sodium and magnesium.

SACRAMENTO ELECTRIC POWER AND LIGHT COMPANY.

The sub-station building of the Sacramento Electric Power and Light Company, corner of Sixth and H streets, Sacramento, which was only partially completed in September last at the time of the Electric Carnival, is now finished. As previously stated, the building is of fire-proof construction, and is of practically three stories, the basement being used for storage purposes, the first floor containing the three-phase synchronous motors and the street railway generators and arc-lighting dynamos, together with suites of offices, while the fourth floor contains the step-down transformer vaults and the testing rooms and supply rooms and other accommodations usual to central stations. On November 1st the city service rendered from the sub-station consisted approximately of 1500 incandescent lamps, about 100 commercial arc lights, and 650 horse-power for street railway uses. The company has also secured the city lighting contract, which will call for an additional 100 arc lamps on December 1st. Three or four hundred horse-power in motor service is also being delivered.

The finishing of the sub-station and the remaining two penstocks and water-wheels at the Folsom power-house practically marked the completion of the entire "Transmission Plant No. 1," and both of these features are illustrated herewith as supplemental to the article describing the plant presented in the September number of The Journal of Electricity.

The fact is also announced that the company has placed on the market its one and one-half million dollars in bonds authorized two years ago by the stockholders, and secured by a deed of trust to the California Safe Deposit and Trust Company. These bonds are in denominations of $1000 each, and bear 6 per cent. interest. Though issued in November, 1893, the managers of the company deemed it advisable to withhold the bonds from sale until the entire plant was completed, and could demonstrate its ability to earn profits, and none have ever been sold. As, however, the plant is now in successful operation, and the earnings have proved sufficient to pay all the operating expenses and bond interest and still leave a handsome margin of profit to the stockholders, application has been made to the San Francisco Stock and Bond Exchange to have the bonds listed, and, after the usual examination by the Executive Committee of the Exchange, the application was granted, and the bonds were on Nov. 20th offered for sale for the first time at $104.

The statement of the officers of the company shows the assets to be as follows:

FIGURES 1 AND 2.—*The Sacramento Electric Power and Light Company's Penstocks at the Folsom Power House, and the Sacramento Sub-station, respectively.*

Hydraulic works at Folsom (cash outlay)	$ 524,837.41
Convict labor performed by the State for certain rights, viz: 700,000 working days at $1 per day	700,000.00
Sacramento street railway system	610,650.00
Toboggan railway at East Park, Sacramento	3,946.00
Transmission plant at Folsom, and transmission line to Sacramento, and buildings and lands	496,289.49
Power and distributing station at Sacramento	73,284.40
Arc and incandescent light distribution system at Sacramento	25,000.00
Total security for bonds	$2,434,007.30
With no indebtedness other than the bond issue of when the same shall have been realized upon.	$1,500,000.00
The gross annual income of the company amounts to	$212,962.36
Deducting—	
Operating expenses and maintenance	$97,697.11
Interest on $1,500,000 bonds	90,000.00
	187,697.11
Leaves an available surplus to the stockholders over all expenses and fixed charges	$ 25,265.25

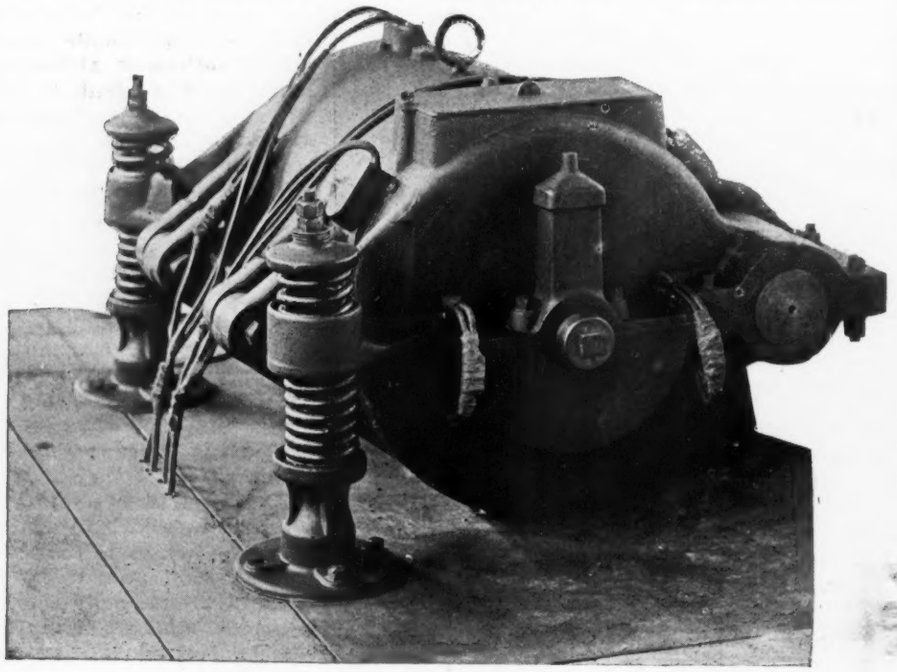
The capacity of the present generating plant at Folsom is 4000 horse-power, the transmission yielding an efficiency in Sacramento of 3000 horse-power, of which only 950 horse-power are being now used in producing the income of the company as above shown.

Contracts for additional power and light are now being made, and when the entire present generating capacity of the company's "Transmission Plant No. 1" is used, the net profits to the stockholder, after the payments of all charges, including bond interest, sinking fund and depreciation, will be upwards of $125,000 per annum, leaving out of the question, at present, future extensions of the generating plant at Folsom, which can be effected without any further expenditures on dam, headworks or canal.

PERSONALS.

Mr. S. Morgan Smith of York, Pa., the builder of the well-known McCormick Turbine, is visiting San Francisco.

Mr. C. D. Crandall, manager of the Western Electric Co., of Chicago, who is making a business tour throughout the Pacific Coast, is at the Palace Hotel, San Francisco.



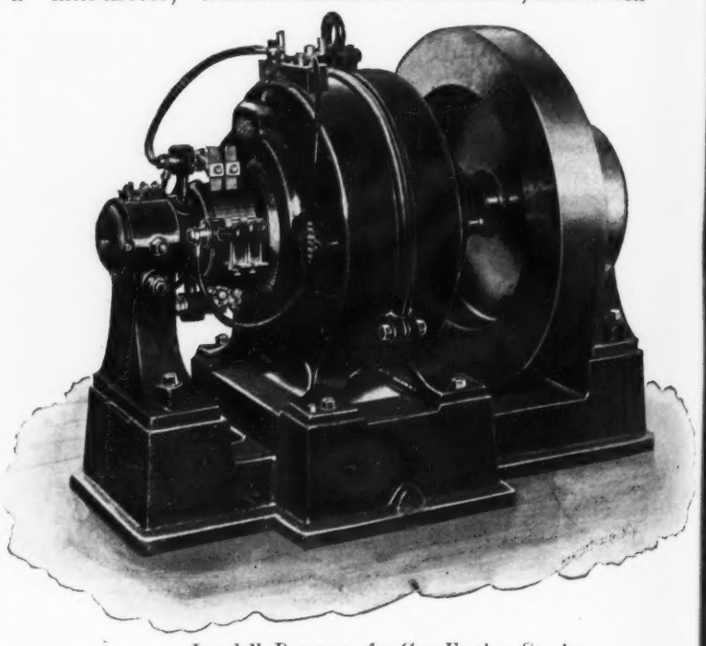
Reversible Mill Motor.

Dr. Thos. Addison, manager of the Pacific Coast office of the General Electric Company, has returned to San Francisco after an eastern business trip of several weeks duration.

The Trade.

SPECIAL REVERSIBLE MILL MOTORS.

The Card Electric Company, of Mansfield, Ohio, has recently brought out a special piece of apparatus termed a "mill motor," which is illustrated herewith, and which



Lundell Dynamos for Gas Engine Service.

is designed for handling heavy machinery in rolling mills, foundries and other places where a strong, simple and serviceable machine is imperative. As the illustration shows, this motor is completely enclosed, and can be used with safety in places where the open type of motor would soon be damaged from dust or occasional wetting.

Particular attention is called to the method of mounting. The front of the motor is supported on a cast-iron stand, rigidly fastened to the bed plate of the machine or other foundation, with trunnions on each side of the upper part taking through suite bearings on the motor case, forming a pivot for the motor to swing on. The rear part of the motor is supported on springs at each side, with springs above, held in compression by bolts through the pedestals, which support them, and which are also fastened to the bed plate. The object of this arrangement is to provide a flexible support for the motor, and a cushion for the gearing when heavy loads are thrown on the motor or the direction of rotation is suddenly reversed. In practice it has been found to work admirably, and, in addition to saving the gears, gives the motor a noticeable advantage in starting heavy loads at slow speed. Where the conditions are such that the spring suspension is not advisable, brackets are provided on the motor for bolting to the bed plate or foundation, rigidly.

The "reversible mill motor" when used with a suit-

able controller and current regulator makes a very desirable outfit for operating cranes, turn-bridges, hoists, bending rolls and other kinds of machinery which require various speeds in either direction. The motors are made in 20, 25, 30, 35 and 40 horse-power sizes, and are handled by the Sterling Electric Supply Company, Pacific Coast agents, San Francisco.

TIE PLATES ON ELECTRIC RAILWAYS.

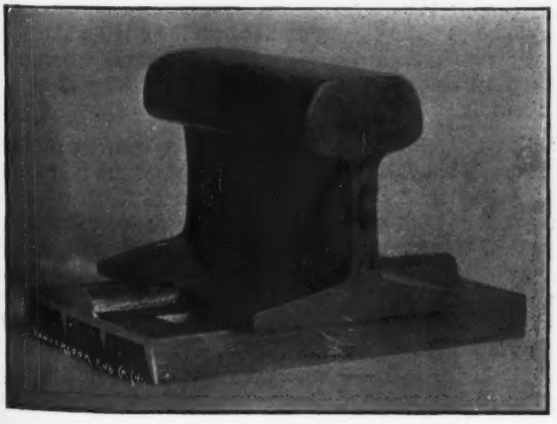
The street railway manager whose ties on country divisions are cut by rail flanges or weakened by frequent spiking, and who has found no satisfaction or adequate prevention of these and similar troubles, will be pleased to learn of the remarkable success being achieved with the Servis Tie-plate on electric lines. These simple appliances, which are used in numberless quantities on steam roads, have only recently been introduced for service on electric lines, but sufficient experience has already been had to demonstrate that with these tie plates, even under the heaviest traffic, the full life of the tie is secured, viz.: cedar, twelve years and upward; black and red cypress, fifteen years and upward; redwood, twenty years and upward. Even in the busy yards of steam roads, under constant and heaviest traffic, ties have their period of usefulness extended from two to eight years and upward, according to the quality of the timber.

As shown in the accompanying illustration, the Servis Tie-plate simply consists of a plate of cast iron, ribbed on one side, and varying in width from $3\frac{3}{4}$ inches to 6 inches. The plates are placed upon the tie with their ribs running parallel with the grain of the wood, and the flanges are driven into the tie when first applied, but after short service the fibre of the tie is compressed, its upper surface is forced down to the plane of the surface of the tie, and a perfect union of the plate and tie thus occurs. Marked economy, not only in the life of the tie, but in preventing spreading of rails or widening of gauge, in breaking ties and rails, and in breaking wheels, occurs, in addition to which the tie plate even tends to hold broken rails securely in place under moving trains.

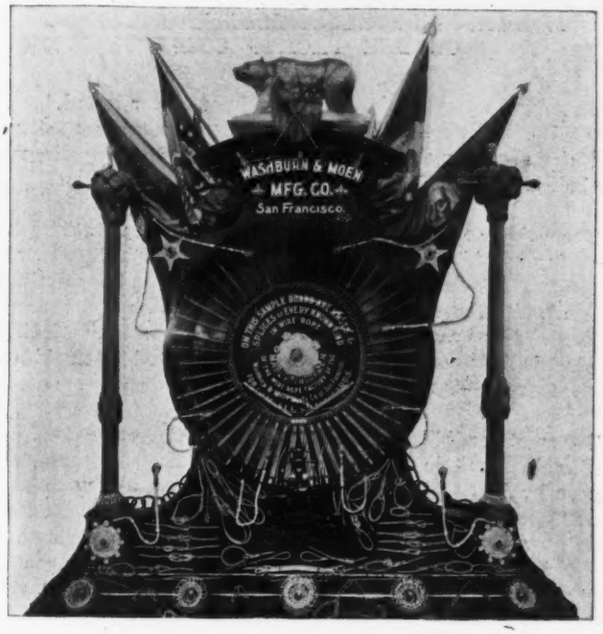
Interesting literature concerning "Proofs of Servis' may be obtained from C. B. Kaufman & Co., 525 Mission street, San Francisco, Pacific coast agents for the Q. & C. Co. of Chicago.

NEW WESTINGHOUSE OFFICE.

The San Francisco office of the Westinghouse Electric and Manfacturing Company is moving from the sixth floor of the Mills Building to the large and commodious suite of offices on the southeast corner of the ground floor of the same building, which will constitute the general offices of the company, and, in addition, has rented the basement of the building, to be used as warerooms. Many car-loads of electrical appliances of every description are being stored there, and hereafter the company will be able to furnish electric lighting, railway or transmission apparatus of almost every description, together with the usual central station supplies, without delay from its San Francisco office on the shortest notice.



Tie Plates on Electric Railways.



Some Products of the San Francisco Works of the Washburn & Moen Mfg. Co.

HANDLING A HEAVY CABLE.

One of the first products of the San Francisco Works of the Washburn & Moen Manufacturing Company is the heavy cable manufactured for the Market Street Railway Company, and which is illustrated on page 122. This cable is 31,000 feet in length, is of $1\frac{1}{8}$ inches in diameter, weighs, including reel and truck, 130,000 pounds, and, as shown, required fifty-six truck horses to haul it. Another almost equally heavy cable, 30,000 feet in length, has recently been shipped to the Front Street Cable Railway Company of Seattle, Wash.

LUNDELL DYNAMOS FOR GAS ENGINE SERVICE.

Herewith is illustrated a modification of the well-known Lundell generator as constructed for service in isolated lighting when the motive power is furnished by a gas engine. Great improvements have been made in the last few years in gas engines, but up to this date no gas engine above 5-horse power has been available, it is said, that could be relied upon to operate at uniform speed. In order to provide for absolutely uniform electro-motive force, or, in other words, uniform incandescence of electric lamps in such a plant, the Interior Conduit and Insulator Co. has built a special generator which carries, in addition to the belt pulley, a fly wheel of heavy rim weight. In this fly wheel is stored up sufficient energy to compensate for the slight inherent irregularities in the speed of the gas engine. It will be observed that extra care has been taken in furnishing substantial pedestals, heavy shaft, and modern self-aligning and self-oiling bearings. The efficiency of the dynamos is from 86 per cent. for the small machines to 95 per cent. for the largest machines.

The Day Press.

POPULAR REFLECTIONS OF THE CONDITIONS AND PROSPECTS OF ELECTRICAL ENGINEERING ON THE PACIFIC COAST.

Thus far the trolley wire, languidly drooping earthward, has exercised a nice discretion, killing only its natural enemy, the horse. But there are many people on earth, and even a trolley wire may be indiscreet.—San Francisco Examiner.

The evidence that trees have been killed by electricity has been furnished by the fact that in numberless instances the trees through which electric light wires pass died in an hour during a storm, while those standing a few feet from the wires were uninjured. These results will raise the question as to the liability of electric light companies for the damage caused by the killing of shade trees.—San Mateo (Cal.) Leader.

The great possibilities for electrical power under the Southern California Mountain Water Company's system is not generally known by the people at large. Recent estimates show that, in the 2000 feet fall of 500 inches of Pine Creek above Barrett dam, 1600 horse power can be developed, and that, in the 1600 foot fall of 1500 inches from Cottonwood Creek, 4300 horse-power can be developed, while between Barrett dam and the city, 2200 horse-power can be developed.—San Diego (Cal.) Union.

Electricity is the coming power for manufacturing, transportation and lighting purposes, and the problem is how and where to secure it best and cheapest. San Bernardino will soon want power for electric cars and for motive power in shops and manufactories, and it is well to look after the supply, or, large as it is, it may be too late to secure it advantageously when wanted. There seems an almost inexhaustible power for the production of electricity in our mountain streams, but it is being secured and utilized, and when a large supply is needed for San Bernardino, it may be too late.—San Bernardino (Cal.) Sun.

The discovery of acetylene may serve as a reminder that the gentlemen who covered many pages of magazines and so many columns of newspapers demonstrating the certainty of the failure of the oil and coal fields, and bewailing the fate of the race when this day came, were wasting their time. Electricity, the development of water powers that electricity has made available, the discovery of acetylene, and the probable discovery of agents even more valuable, make it likely that coal and oil will be displaced from use or relegated to an unimportant position long before the supply of these products in the earth's treasuries have come to an end. It is just as well to avoid crossing bridges before we get to them, and we need not despair of the future of the race till the catastrophe that may threaten it has actually come. The resources of the future may not be inexhaustible, but they are beyond the reasoning of the finite mind.—San Francisco Chronicle.

It is quite common to hear of irrigation works being utilized for the generation of electric power. In all parts of this State where large dams have been constructed or are being constructed or projected for irrigation purposes, the people are contemplating the establishment of manufacturing plants to be operated by electricity generated by the water power developed at the dams. The water power at La Grange developed by the dam of the Turlock and Modesto Irrigation district, which dam cost $650,000, and is the highest in the world, is to be utilized in this way. A combined power and irrigation company has recently been organized at Kaweah, and every day brings news of similar enterprises in other parts of the State. The effects of this union of irrigation and electric power plants is sure to be highly beneficial to the public. The capital invested primarily for irrigation purposes will be earning interest in two directions. This will result in making both irrigation and electric power cheaper to the consumer than either would be without the other. Another good effect will be that irrigation projects, which would not be undertaken on account of the expense or of the small area to be accommodated, can be made profitable by using the water for the generation of electric power. We have no doubt that this will cause the development of vast agricultural areas, which would otherwise have remained arid and unproductive. The use of water for irrigation and motive power will thus make deserts to blossom as the rose, and convert dry pasture lands into rich farming communities dotted with towns and villages, vocal with the hum of machinery and the songs of prosperous artisans. It is usual to speak of Santa Cruz County as being in no need of irrigation. This is true, comparatively speaking. Our county is not subject to the drouths which afflict other portions of the State. But irrigation would pay even in Santa Cruz. A glance at the market gardens of Chinese and Italians in this vicinity will convince any observer of the truth of this proposition. There are scores of small valleys and mesas in the county, which might be bearing three luxuriant crops a year instead of one crop as at present. All that is needed to treble or quadruple the productive capacity of large Santa Cruz areas is to spread upon them some of the liquid treasures of the mountain streams that go idly to the sea. These streams should be utilized for irrigation and electric power. Santa Cruz should not be behind in the procession, which is moving on towards wealth and prosperity in other parts of the State under the combined banners of irrigation and electric power.—Santa Cruz (Cal.) Sentinel.

MISCELLANEOUS.

Oakland, Cal.—The Electric Specialties Co. has adopted the novel means of advertising of giving evening street lectures on electricity.

Yokohama, Japan.—A double nozzle six-foot, 150-horse-power Pelton wheel, to run under 120-foot head, is being installed in the silk weaving mill.

Salt Lake City, Utah.—F. M. Ulmer is experimenting at the Ontario mine with an electrical device designed to save quicksilver and all other free metals in tailings.

Blue Lakes, Idaho.—I. B. Perrine proposes to construct a dryer for evaporating fruit, in which electricity, presumably to be generated at Shoshone Falls, will be used to generate heat.

Reno, Nev.—A quarterly license, ranging from $25 on corporations whose monthly receipts equal or exceed $10,000 down to $10 on corporations whose monthly receipts are between $1,000 and $2,000, has been levied upon the water, gas and electric lighting industries of this city.

Stockton, Cal.—The estimated steam power consumption in this city is approximately 1750-horse-power, apportioned principally as follows: The Sperry and Crown flour mills about 450-horse-power each, the Union Mill about 300-horse-power, and the Gas Company about 350-horse-power, the present cost of same being about five dollars per horse-power per month.

San Francisco, Cal.—The Electrical Engineering Company reports the sale of two direct-connected double worm gear electric passenger elevators, to be used in Dr. Hertzstein's office building and hospital, and one high-speed electric elevator to be used in the new Cliff House. This latter elevator will have a travel of 125 feet, which is the highest in the city.——W. P. Freeman of Boston proposes to establish a factory for the manufacture of rubber and electrical appliances.——The Safety Electric Elevator Company has been incorporated by J. W. Gentry and others. Capital stock, $100,000.——Among the recent installations made by the Girard Water Wheel Company are the following: A 50-horse-power Girard wheel for the Channel Bend Mining Company near Volcanoville, Cal., and a 200-horse-power Girard wheel for the Ontario Electric Company of Ontario, Cal.——H. A. Russell, late manager of the Pacific Coast office of the Westinghouse Electric and Manufacturing Company, has accepted the selling agency of the General Electric Company.

Reports of the Month.

LITIGATION.

San Francisco, Cal.—The Superior Court has decided, in the suit of Lucien Spencer vs. The Market Street Railway Company for $25,000 damages for personal injuries, that a street railway company is not liable for injuries sustained by a person who has been pushed off a car by some one other than an employee.

Spokane, Wash. —Judge Moore has decided that the original franchise of the Union Light and Power Company has expired by reason of failure to begin operations in good faith within the time specified, or within a reasonable length of time. An injunction preventing the Chief of Police from removing poles that have been erected was therefore denied.

Sacramento, Cal.—The Western Electric Company has brought suit in the United States Circuit Court against the Capital Telephone and Telegraph Company for alleged infringement of Leroy B. Firman's patent No. 252,576, dated January 17, 1882, on multiple switchboards, and on the Watson patent, No. 270,582, of January 9th, 1883.——Judge Catlin, of the Superior Court, has issued a peremptory writ of mandate commanding the Central Electric Railway to sell and supply to E. W. Hale et al., petitioners, such school passes as the petitioners may require to furnish its customers. This the railway company had refused to do because of a contract previously entered into with another business firm, as a result of which Hale Bros. & Co. were prevented from receiving such passes.——Allen L. Clare has sued the Sacramento Power & Light Co. for $50,150 damages and costs for personal injuries alleged to have been received from a charged guy wire.

COMMUNICATION.

Stockton, Cal.—The Gamewell Co. has sold to thecity twelve Standard Gardner boxes, and three 15 inch combined gongs and indicators.

Los Angeles, Cal.—The Board of Public Works has recommended that the bids of Herman de Laguna for $333.00 for a telephone franchise be accepted.

Tulare, Cal.—Seven Excelsior Gamewell boxes, together with a tower-bell and other Gamewell apparatus, constitute the new fire-alarm system recently installed.

Santa Barbara, Cal.—The fire-alarm system has been increased by the addition of eight non-interfering Gamewell boxes, one bell-striker, one combined gong and indicator, and four miles of circuit, all of the Gamewell system.

Eureka, Cal.—The John Vance Mill and Lumber Company has secured the privilege of laying and maintaining a submarine telephone cable from Eureka to the Samoa Mill, via Woodley and the Gunther Islands, across the intervening channel.

San Jose, Cal.—The People's Telephone and Telegraph Company has been incorporated for the purpose of building a telephone system in this city, to work in conjunction with the outside lines of of the California Telephone and Construction Company.

Portland, Or.—The Oregon Electrical Construction Company has been incorporated to build and operate telephone and telegraph lines and branch lines between Portland and Astoria. Capital, $20,000; incorporators, G. F. Huesner, F. C. Miller and J. S. Urquhart.

Tucson, Ariz.—Chas. F. Hoff proposes to install a telephone system at Nogales and Tucson this winter, and will endeavor to connect Phœnix with Prescott and later extend to Flagstaff, after which he will work the other way, from Tucson to Oracle, thence to Mammoth, Florence and Mesa, making a continuous line from Nogales to Flagstaff.

TRANSPORTATION.

Phoenix, Ariz.—The Five Points Street Railway Company proposes to substitute electric for mule power, and to extend its system to Alhambra and Glendale.

San Jose, Cal.—The Board of Trade has pledged itself to use its best endeavors to raise $50,000 towards the construction of the San Jose and Saratoga Electric road.

Santa Cruz, Cal.—The Electric Railway Company denies the report that it will install a power plant, as it is under contract to buy power from the Electric Light Company until next September.

Vancouver, Wash.—An electric road to cost $200,000 is projected to run from this city through Fruit Valley to some point on Vancouver Lake or Salmon Creek.

Stockon, Cal.—James A. Louttit states that work on the Stockton and Lodi Terminal Railway will probably be resumed soon, and that the change in the proposed motive power from steam to electricity is contemplated.

Sacramento, Cal.—The Chamber of Commerce has appointed a committee to call on the contestants along the line of the proposed Orangevale and Sunset Colony Electric Railroad, and endeavor to remove the temporary obstacles in the way of at once starting the work.

Santa Monica, Cal.—The Pasadena and Pacific Electric Railway Company proposes to build a branch line on Oregon Avenue, from Ocean Avenue to Twenty-seventh street.—— The first section of the Los Angeles and Pacific Electric Road is completed to the Junction, and is in operation.

Oakland, Cal.—The San Pablo Avenue Cable Line is to be changed to an electric system next year, when it will be extended from Emeryville along San Pablo avenue to West Berkeley, with a loop from the main line to the present terminus of the Telegraph avenue system at the University. Power will be taken from the Temescal power-house.

Seattle, Wash.—The Front Street Cable Railway Company has received from Washburn & Moen a 1⅛-inch cable 30,000 feet in length. This cable was made in San Francisco, and was shipped by rail, as it was too heavy to handle by water.——L. H. Griffith, of this city, left for Central America October 30th, where he expects to build an electric railway.

Santa Barbara, Cal.—The first spike in the new line of the Santa Barbara Consolidated Electric Railway system was driven by Mr. A. Hope-Doeg on October 11th ——The Consolidated Co. has completed arrangements to erect its power-house in Summerland, and will place therein a 500-horse-power engine and boiler, and two 75-horse-power generators.

Los Angeles, Cal.—W. D. Larrabee has been granted a special franchise to construct and operate an electric road for a period of twenty-three months, from Fair Oaks Avenue, on Pasadena street, to the Mountain View Cemetery, with two branches.——Among improvements contemplated by the Los Angeles Consolidated Railway Company are the equipping of the Boyle Heights, East Side, West Lake and Grand Avenue Cable Lines with electricity, and the converting of the Central Avenue Cable engine-house into an electric power-house. A 1000 horse-power engine has been ordered for the latter, and bids are out for a 1200 horse-power engine for the same place. The company is employing about 600 men, 400 of which operate the cars, etc.—— The Boyle Heights and West Side Park branches of the Los Angeles Railway Company will be in operation by December.——A bond has been filed by W. S. Hook in the sum of $10,000 for the faithful carrying out of the franchise granted him by the Council for the building of an electric street railway from the intersection of Freeman and Bush streets, southwest on Bush to Hoover, thence south on Hoover to Forrester Avenue.

TRANSMISSION.

MESA, ARIZONA.—Contractor Van Slyke of Phœnix is to build the Consolidated Company's new power house.

LOS ANGELES, CAL.—Ordinance No. 3151 has been passed, granting W. S. Hook, Manager, a street railway franchise.

NEWCASTLE, CAL.—The pole line of the South Yuba Electric Co. is being erected between Newcastle and Roseville, and will reach Sacramento before New Year.

LEMOORE, CAL.—The West Side Land and Canal Co. proposes to irrigate lands on the west side of Kings River, raising the water from wells by means of electric pumping plants.

VANCOUVER, B. C.—F. S. Barnard has notified the City Council that he has procured sufficient English capital to install a transmission plant for operating the street railway and lighting systems.

TUOLUMNE COUNTY, CAL.—The Rawhide mine has ordered a 500-horse-power three-phase G. E. transmission plant, the distance of transmission being ten miles, and the generators to be direct driven from Pelton wheels.

SONORA, CAL.—P. J. Sullivan, Secretary of the Buchanan Mining Company, states that the company will build the dam in Hunter Cañon, from which ample power will be derived to operate the Buchanan and Hunter mines by electric power.

CITY OF MEXICO, MEXICO.—Ramon Sanchez has ordered a 600 horse-power three-phase transmission plant to be direct driven from Pelton wheels to operate his paper-mills. The order was placed through S. C. Peck of the International Thomson-Houston Company.

LOGAN, UTAH.—T. A. Davis, promoter of the Hercules Electric Light Co., together with P. M. Munn & Eldon P. Bacon, electrical engineers, formerly of Telluride, Colorado, are about to commence work on the plan, which proposes to transmit 1000 electrical horse-power from the water-power of Logan Cañon, three miles distant.

SAN FRANCISCO, CAL.—The new electric lines on Ellis, O'Farrell, Devisadero, Fillmore, Turk, Eddy and Page streets are now in regular operation.——A force of 2000 men were put at work on the Ingleside extension on November 1st in order that the electric road might be completed to the new race track by Thanksgiving Day.

SACRAMENTO, CAL.—The Central California Electric Light and Power Co. (The North Yuba Canal Co.) has been awarded the county franchise for erecting a transmission line along the county highways, between the Placer County line near Antelope and the city limits.——The Bee expresses the belief that friendly relations exist between the Central California Electric Co. and the Capital Gas Co., and that, if the former does not desire to retail electric light and power, its output will probably be acquired by the Capital Gas Co.

FRESNO, CAL.—Work on the thirty-five mile transmission plant of the San Joaquin Electric Company is progressing satisfactorily. The canal and flume are completed, the reservoir is well under way, and five carloads of copper wire is being strung. The Fresno sub-station is being erected near the corner of O and Fresno streets.——The San Joaquin Electric Co., which will undoubtedly be in operation by February 1st, has thus far arranged to supply power to the Mandary Planing Mill, the Fresno Agricultural Works, the Sperry Flour Mills and the City Water Works.

ANGELS, CAL.—Geo. W. McNear proposes to build a dam about three miles below Bostwick Bar to develop about 2000 horse-power of electric power for operating mines in this vicinity. The Stanislaus River at the site of the dam is 155 feet wide and confined by cliffs 300 feet high, and 40,000 miner's inches of water have been located. Henry L. Smith is to be in charge of the engineering.——Newspapers report that the Utica mines have contracted for a large electric plant to furnish 1000 horse-power for running the company's mills. The water wheels will be run under a head of nearly 1700 feet, and the scheme involves a transmission of eight miles from Murphy's Cañon to Angels.

STOCKTON, CAL.—The Blue Lake Water Company is maturing plans for installing an electric transmission from the Blue Lake region down the Mokelumne River to Wallace, and from there on to this place. Near the Big Bar bridge of the Mokelumne River a fall of 1043 feet can be developed, which is said to be capable of generating 50,000 horse-power. At the present, the company is taking water from its reservoirs, which is used for mining purposes, and, it is stated, that there is sufficient water power now going to waste to generate 8000 horse-power. It is believed that at least 2000 horse-power can be used in this city from the outset, and work will be commenced as soon as sufficient power has been contracted for to pay a reasonable return on the investment.——Still another project for transmitting electric power to this city has been started, the latest scheme being to utilize the water of the Salt Spring Valley reservoir, twenty-four miles distant. It is said that 7000 horse-power can be delivered.——Sidney Newell, Jr., is exploiting an electric transmission project to use the water power of the Blue Lakes, forty miles distant. The installation of two 1000-kilowatt alternators is proposed at an estimated cost of $164,336, exclusive of buildings, water-wheel plant, water developments or local distributing circuits. This project is entirely distinct from the original Blue Lakes scheme that has long been before the public.——The transmission of 2000 horse-power from Mokelumne Hill is talked of.

ILLUMINATION.

TACOMA, WASH.—Since the reduction in rates the business of the city lighting plant has been increased to the fullest capacity of the plant, which is 5000 incandescents and 750 arc lamps.

SAN BERNARDINO, CAL.—The Trustees have advertised for bids for from 60 to 100 arc lights, to be furnished for one year from December 15th, and all bids to be in by noon, December 5th.

CATHLAMET, WASH.—Will Smith expects to put in an electric light plant, to be operated by water power from Birney Creek.——The Clifton Cannery has been fitted up with an electric light plant.

SAN PEDRO, CAL.—J. E. Tult and Charles C. Glass have applied for an electric lighting franchise ——The Long Beach Electric Light Co., having secured the city lighting franchise, has ordered a Corliss engine and dynamo.

OAKDALE, CAL.—L. P. Drexler, of San Francisco, is interested in a project to establish a light and power plant for this place, to be operated by water power taken from the flume across the Stanislaus River, sixty miles above.

MISSOULA, MONT.—H. M. Byllesby, President of the Missoula Electric Light and Power Company, has arranged with the Bonner Company for improved facilities with which to operate the plant, and the work of installation is progressing rapidly.

MODESTO, CAL.—The Modesto Gas Company has secured the contract for street lighting for one year from December 1st at the rate of $3 per 50-candle-power lamp per month, moonlight schedule, and $4.50 per 50-candle-power lamp per month, all night schedule.

SONORA, CAL.—The Grant Bannister Company has bought the electric lighting plant of the Sonora Electric Light Company, which will be enlarged by the addition of a 200-kilowatt three-phase generator, and will be moved about four miles out of town, where water power is available.

SACRAMENTO, CAL.—The South Yuba Co. has been granted the privilege to erect poles for its proposed transmission lines in Sacramento County.——The annual contract for lighting the city has been awarded to the Sacramento Electric Power & Light Co. for $8.75 per lamp per month. The former rate was $14.95 per month.

MINAS PRIETAS, ARIZ.—Thomas Douglas, of San Francisco, has been appointed electrician of the Minas Prietas mills, mines and telephone lines.

MONTESANO, WASH.—Albert Daub is to light the city for two years in return for electrical supplies valued at $741, which the city has on hand.

COTTAGE GROVE, OR.--Mr. Anderson is putting in a plant for city lighting in a building adjoining Stone's mill, from which power will be taken.

ANACONDA, MONT.—New water wheels, dynamos, and other equipments are to be placed in the plant of the Anaconda Light and Power Company.

ABERDEEN, WASH.--E. B. Benn and C. R. Green have leased the Electric light plant for one year, and will inaugurate needed changes in the system.

SAN LEANDRO, CAL.—A special election will be held on December 16th for the purpose of incurring an indebtedness of $10,000 for an electric light plant.

BINGHAM, UTAH.—O. B. Hardy and W. J. Moorhead have received an electric franchise for operating a light and power plant in the West Mountain Mining district.

REDWOOD CITY, CAL.—J. George Gardner is installing an electric lighting plant here, and proposes to extend lighting circuits to Menlo Park, Palo Alto and Woodside.

EUREKA, CAL.—The National Incandescent Lighting dynamo formerly used on the Steamer Humboldt has been taken from the wreck of that vessel and will be installed on the steamer National City.

SALT LAKE, UTAH.—The Gas and Electric Light Company proposes to erect a business block on State street in which will be located its offices and the distributing station for the Big Cottonwood plant.

REDWOOD CITY, CAL.—Chas. Jones has placed an isolated lighting plant in his residence, consisting of a 5-kilowatt Westinghouse multipolar dynamo direct, driven from a small Pelton water-wheel, operating under 500-foot head.

RIVERSIDE, CAL.—The Redlands Electric Light and Power Co. have contracted to furnish the city with 200 horse-power of electricity for ten years at $36 per horse-power per year for continuous service, and the amount of power to be increased to 600 horse-power when the city may desire it.

NEVADA CITY, CAL.—K. Casper proposes to supplement the present 1000-light Heisler incandescent system with a 200-kilowatt polyphase generator for delivering light and power. The services of W. Stuart-Smith and Sidney Sprout have been retained as consulting and supervising engineers.

OAKLAND, CAL.—The Oakland Light and Motor Co. has elected the following officers for the coming year: Thomas Addison, president; W. S. Harlow, vice-president; Edward Barry, secretary. The board of directors consists of Thomas Addison, F. F. Barbour, W. S. Harlow, W. L. Prather and Edward Barry; superintendent, R. P. Valentine.

STOCKTON, CAL.—The Stockton Gas, Light and Heat Company proposes to place a large gas engine in its electric light plant, in view of which it has entered into a contract with Jerome Haas to sink a well for natural gas at the corner of Ninth and Hunter streets.——The Stockton Gas and Electric Co. contemplates manufacturing ice.

SAN FRANCISCO, CAL.—The Pan Handle of Golden Gate Park has been lighted by arc lamps, as the result of the regent agitation on the subject.——The newspapers state that an agreement has been reached between the San Francisco Gas Light Company and the Edison Light and Power Company, by which there are to be no more hostilities at present.

SALT LAKE CITY, UTAH.--The Salt Lake and Ogden Company has materially enlarged its plant by the addition of new dynamos and machinery preparatory to meeting the competition of the Citizens' Electric Light Company.——The incandescent installation in the Silver King Mine has been completed. A. V. Officer has been appointed superintendent of the Citizens' Electric Light Company.——A rate war is in progress between the Citizens' Company and the Salt Lake and Ogden Company, as a result of which arc lights have been put in at $2.50, where they formerly brought $10 50.

SAN FRANCISCO, CAL.—The John M. Klein's Electrical Works has succeeded W. J. O'Connor to the Pacific Coast agency for the Sunbeam Incandescent Lamp Co.——The Mutual Electric Light Company has enlarged its plant by the addition of a 60 kilowatt Westinghouse alternator.——The contract for the steam and electric plant of the Parrott building has been awarded to the Union Iron Works, which will install six 100-kilowatt and two 30-kilowatt, 110 volt generators, each direct connected to a triple expansion marine type engine. Internal fired boilers are to be used, and the plant, which is to be run condensing, is to be wired for 320 constant potential arcs, 5000 incandescent and 15 Sprague-Pratt elevator equipments.

SAN JOSE, CAL.—An understanding between the Electric Improvement Company and the San Jose Light and Power Company is believed to have been effected, though it is denied by the officials.——The Board of Trade has passed a strong resolution favoring municipal ownership of an electric lighting plant, and City Attorney W. B. Hardy has rendered an opinion to the Mayor and Common Council to the effect that the City has full power to regulate the price of artificial light. The reports of combination between the two lighting companies seem to be confirmed by the fact that the price for arc lamps has been increased fifty cents per week.

ALAMEDA, CAL.—It is proposed to add a 350-horse-power compound condensing Corliss engine and boilers, and a 2500-light alternator to the municipal lighting plant.——Al V. Fisher has been appointed assistant engineer and collector of the city lighting plant.——The City Trustees have about concluded to take down the electric light masts.——Expert J. A. Sansome has rendered a report showing that the cost of operating the city electric light plant for five years ending March 31, 1895, to be $64,045.67, or $12,809.13 per year. The construction per year is $3,000, the maintenance per year $9,743; the cost per lamp for 90 lamps, per year, is $105.25, and the cost per lamp, per month, is $8.25.

LOS ANGELES, CAL.—W. B. Carter will place an electric light plant in the $15,000 resort he proposes to erect at the lake in Echo Park.——The City Electric Power and Lighting Company proposes to furnish all city buildings with electric light free of charge, provided a special electric light franchise be granted it. The Board of Supervisors has amended the license ordinance so that a tax of $15 per month shall be imposed on gas companies, while the tax on electric lighting companies shall be graduated as follows: Plants operating less than 500 lights, $2 per month; between 500 and 1000 lights, $10 per month; over 1000 lights, $15 per month.——F. N. Meyers has been elected President of the City Electric Power and Lighting Co.

SEATTLE, WASH.—A. L. Hawley, assistant manager, and J. I. Robinson, secretary of the Union Illuminating Company, have resigned, to take effect November 1st.——The combination that has been in existence for many months between the Union Electric Company and the Seattle Gas and Electric Light Company, which has been operating as the Union Illuminating Company, has been dissolved, and its component members are again in active competition.——F. H. Osgood, A. L. Hawley and J. T. Robinson have submitted a tender to build the city a lighting plant, with poles or conduits, supplying everything for 665 incandescent 15-candle-power lights, and 81 arcs of 2000-candle-power at $7.25 per month for the latter, and $1 per month for the incandescent. The city is to purchase the plant in three years.

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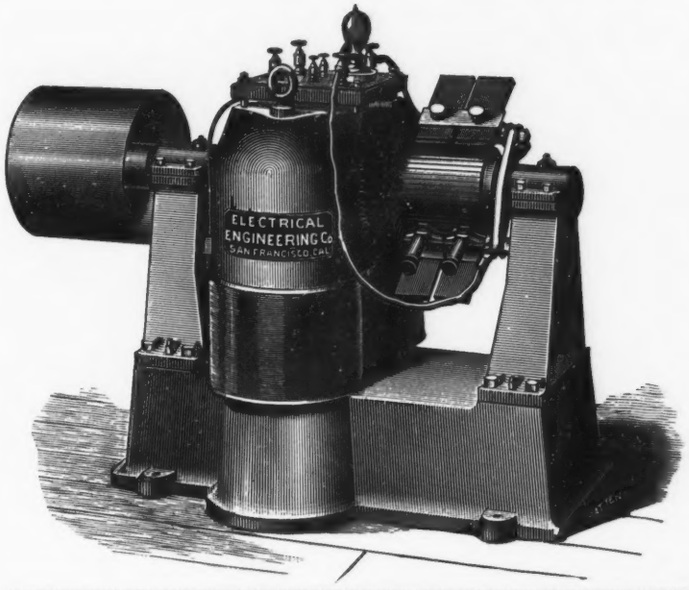

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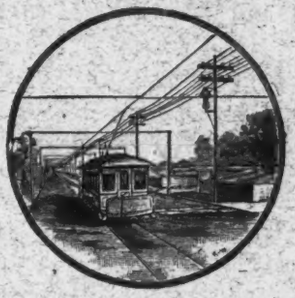

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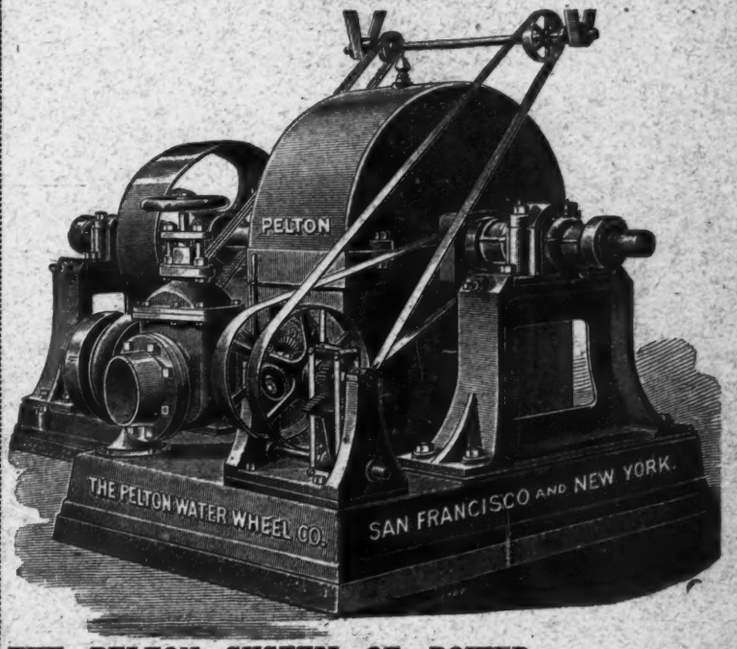

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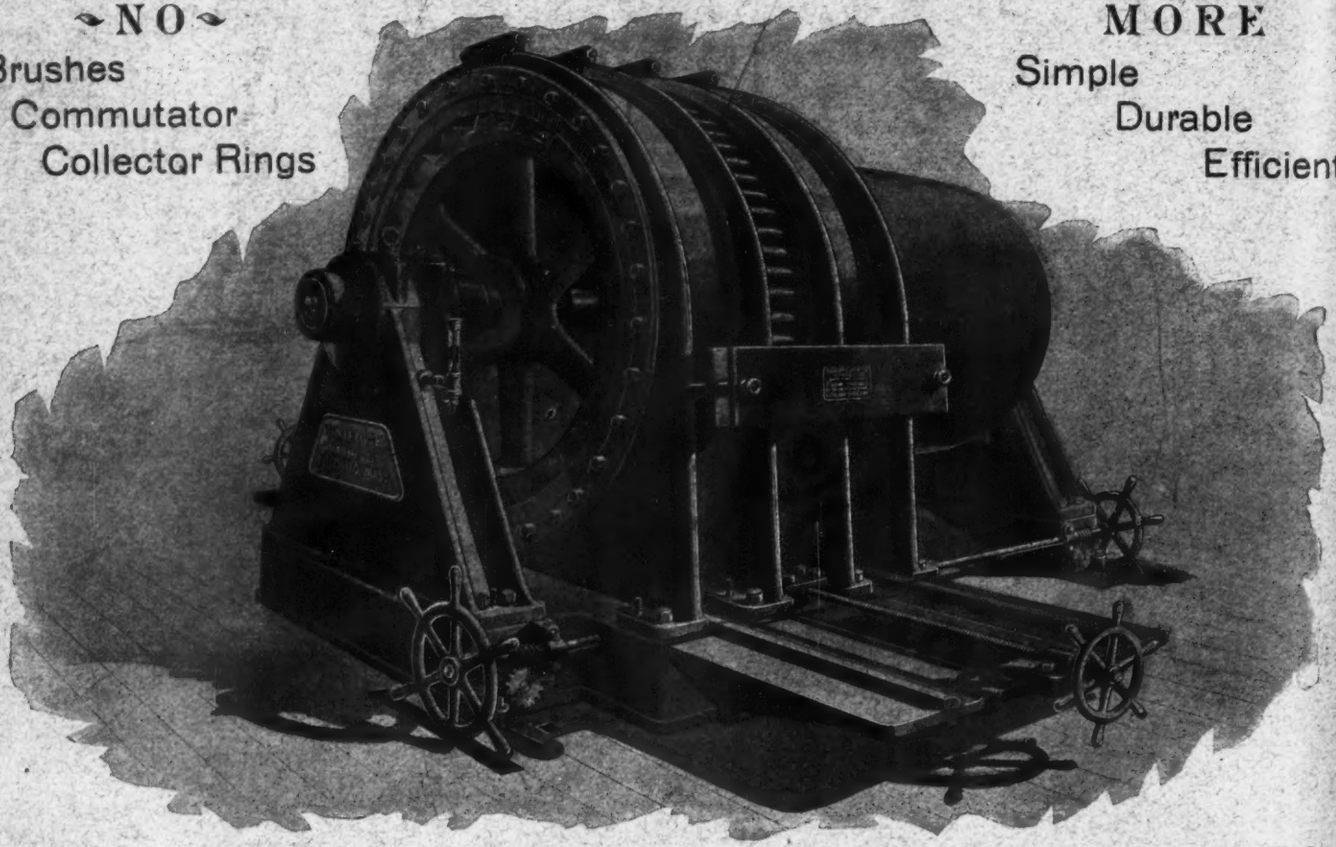

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